1992

KENTUCKY
REPORT TO CONGRESS
ON
WATER QUALITY

COMMONWEALTH OF KENTUCKY
NATUAL RESOURCES AND
ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

DIVISION OF WATER

APRIL 1, 1992

ERRATA: In the second paragraph on page viii change 10,671 miles to 10,659 miles.

On Figure VI page xvi change pie diagram reflecting size by acres as follows: white slice should be oligotrophic, 63,513 acres and hatched slice should be mesotrophic, 42,444 acres

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF TABLES AND FIGURES

LIST OF TABLES AND FIGURES

LIST OF TABLES AND FIGURES

ACKNOWLEDGEMENTS

The staff of the Water Quality Branch within the Division of Water are primarily responsible for the preparation of this report. Their dedication, persistence and willingness to put in many extra hours of work is to be commended. Also, appreciation is given to personnel in the KPDES Branch, Groundwater Branch, Facilities Construction Branch, and Field Operations Branch, for their contributions to the report. Assistance from the Division of Environmental Services, the Ohio River Valley Water Sanitation Commission, the Division of Conservation, the Department of Fish and Wildlife Resources, the U.S. Army Corps of Engineers, the Department of Parks, Dr. Joe King and his associates at Murray State University, and Jerry Terhune and his associates affiliated with the Louisville and Jefferson County Metropolitan Sewer District, is also greatly appreciated.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report was prepared to fulfill requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 82-500) as subsequently amended and commonly known as the Clean Water Act. Section 305(b) requires that states submit a report to the U.S. Environmental Protection Agency (EPA) on a biennial basis which assesses current water quality conditions. This report presents an assessment of Kentucky's water quality for the period 1990 through 1991. Topics that are discussed in the report are groundwater quality, the status of the state water pollution control program, water quality conditions and use support of streams, rivers and lakes, a discussion on wetlands, and recommendations on additional actions necessary to achieve the objectives and goals of the Clean Water Act.

Water Quality Assessment

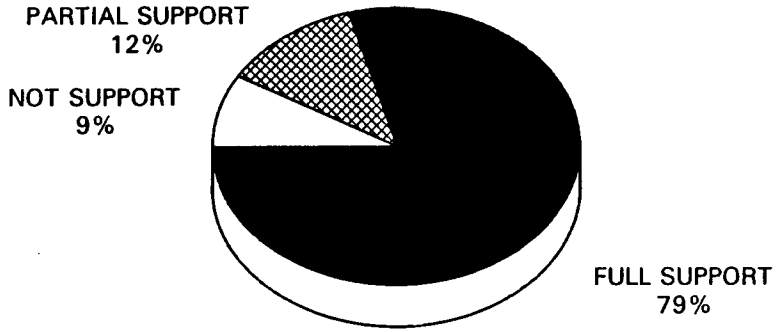
The water quality assessment of rivers and streams in Kentucky's 1992 report is based on those waters depicted on U.S. Geological Survey 1:100,000 scale topographic maps of the state. The maps contain about 55,300 miles of streams, of which approximately 10,671 miles (19%) were assessed. This is a decrease in terms of percentage assessed because the base map used in the last report was larger in scale (1:500,000) and had fewer streams. The change to a smaller scale map was requested of states by EPA in order to establish national consistency on waters to be assessed.

The main assessment is based on an analysis of the support of classified uses in state waters excluding the Ohio and Mississippi rivers. Aquatic life and swimming uses were most commonly assessed. Full support of uses occurred in 6656 miles (68%) of the assessed waters and uses were not supported in 2083 miles (21%). Partial use impairment was found in 996 miles (10%) of the assessed waters. Swimming use was impaired to a far greater extent than aquatic life use (Figure I). The major causes of use nonsupport were fecal coliform contamination (pathogen indicators), which affected swimming use, and siltation and organic enrichment, which impaired aquatic life use (Figure II). The major sources of the fecal coliform contamination were municipal wastewater treatment plant discharges and agricultural nonpoint sources. Municipal point sources were responsible for the organic enrichment, while surface mining and agricultural nonpoint sources were the major sources of siltation. Municipal discharges were the primary point source contributor to nonsupport of uses and agricultural activities and resource extraction were the major contributors to nonsupport from nonpoint sources (Figure III).

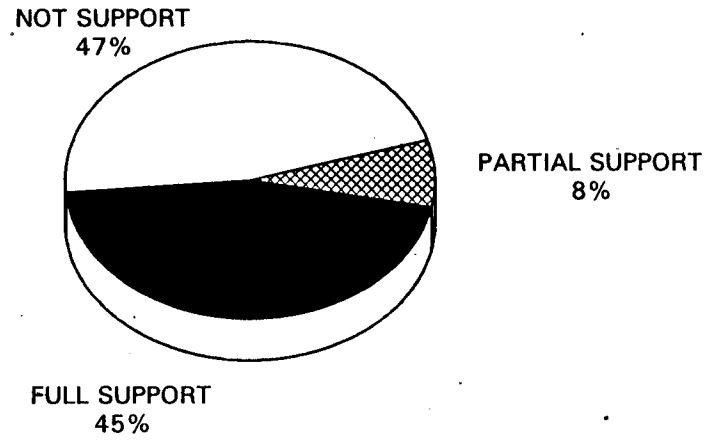
There were some notable improvements in water quality. Blaine Creek, the South Fork of the Kentucky River, the Kentucky River from Heidelberg to Camp Nelson, and the Licking River near Salyersville exhibited a decrease in chloride concentrations. The domestic water supply use in the Licking River near Salyersville and aquatic life use in Blaine Creek were fully supported, whereas these uses were not supported in the last

Figure I

SUMMARY OF INDIVIDUAL USE SUPPORT
RIVERS AND STREAMS



AQUATIC LIFE



SWIMMING

Figure II

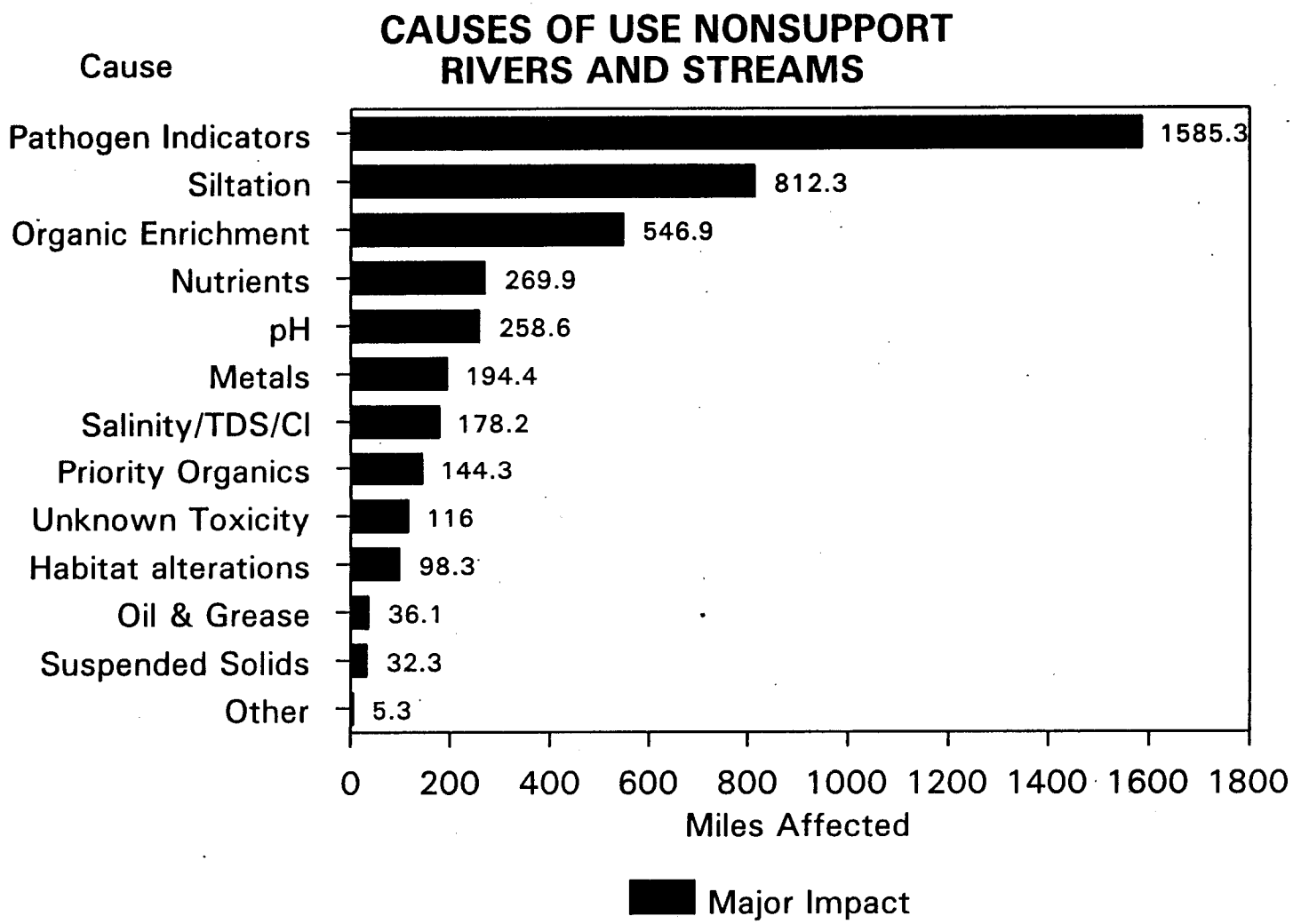
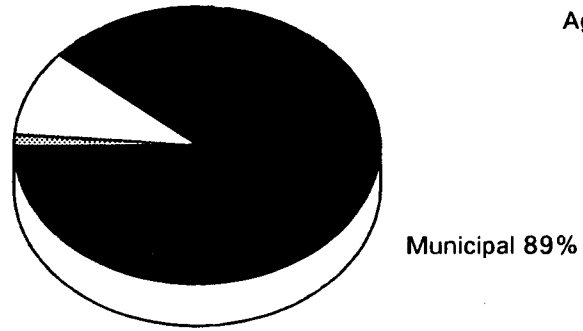
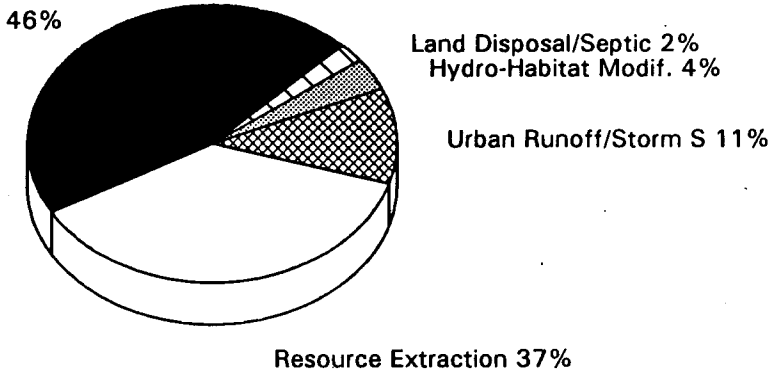

CAUSES OF USE NONSUPPORT
RIVERS AND STREAMS
Cause
Pathogen Indicators
Siltation
Organic Enrichment
Nutrients
pH
Metals
Salinity/TDS/Cl
Priority Organics
Unknown Toxicity
Habitat alterations
Oil & Grease
Suspended Solids
Other
1585.3
812.3
546.9
269.9
258.6
194.4
178.2
144.3
116
98.3
36.1
32.3
5.3
0
200
400
600
800
1000
1200
1400
1600
1800
Miles Affected
Major Impact

Figure III

SOURCES OF USE NONSUPPORT
RIVERS AND STREAMS



Point Sources



Nonpoint Sources

reporting period. The decrease in chlorides is attributed to enforcement of KPDES permit limits on oil and gas production facilities, possible decreases in production, and differing stream flow regimes.

The swimming use in the Kentucky River was supported in areas where the use had previously not been fully supported. Bacteriological surveys at Lake Cumberland indicated that the swimming use was supported in the main lake and around major marinas and houseboat docking areas. The closure of the beach on the Kentucky River at Boonesboro was the only beach closed by the Parks Department during this reporting period. Fecal coliform contamination caused swimming advisories to be posted for the North Fork of the Kentucky River above Jackson, and for the Licking River and some tributary streams near Covington.

Degradation due to priority pollutants has occurred in some of the state's streams. Fish consumption warnings remain posted for the Mud River and Town Branch in Logan, Butler, and Muhlenberg counties because of contamination from PCBs. A fish consumption advisory remains in effect for the West Fork of Drakes Creek in Simpson and Warren counties, and Little Bayou Creek in McCracken County because of contamination from PCBs. The Ohio River remains posted with advisories because of PCB and chlordane contamination. The Ohio River advisories are specifically for the consumption of channel catfish, carp, white bass, paddlefish, and paddlefish eggs.

Thirty-three fish kills totalling 134,208 fish were reported during 1990-1991, affecting over 56 miles of streams and 26 lake acres. The number of fish kills reported and the number of waterbodies affected were fewer than those reported over the last four years, as were the number of miles affected and the number of fish killed. Fish kills were most commonly attributed to sewage discharges and to unknown causes.

The water quality assessment of lakes included more than 90 percent of the publicly-owned lake acreage in Kentucky. Sixty-four of 102 lakes (63 percent) fully supported their uses, 29 (28 percent) partially supported uses, and nine (9 percent) did not support one or more uses. On an acreage basis, 91 percent (195,293 acres) of the 214,962 assessed acres fully supported uses, while 6 percent partially supported uses, and 3 percent did not support one or more uses (Figure IV).

Nutrients were the greatest cause of the uses not being fully supported and affected the largest number of lakes. Agricultural runoff and municipal discharges were the principal sources of the nutrients. Iron and manganese were the second greatest cause of use nonsupport, and affected the domestic water supply use. Natural release of these metals from bottom sediments into the water column causes water treatment problems. Suspended solids from surface mining activities impaired the secondary contact recreation use in several eastern Kentucky reservoirs. Figure V shows causes and sources of use nonsupport in lakes.

Figure IV
SUMMARY OF LAKE USE SUPPORT

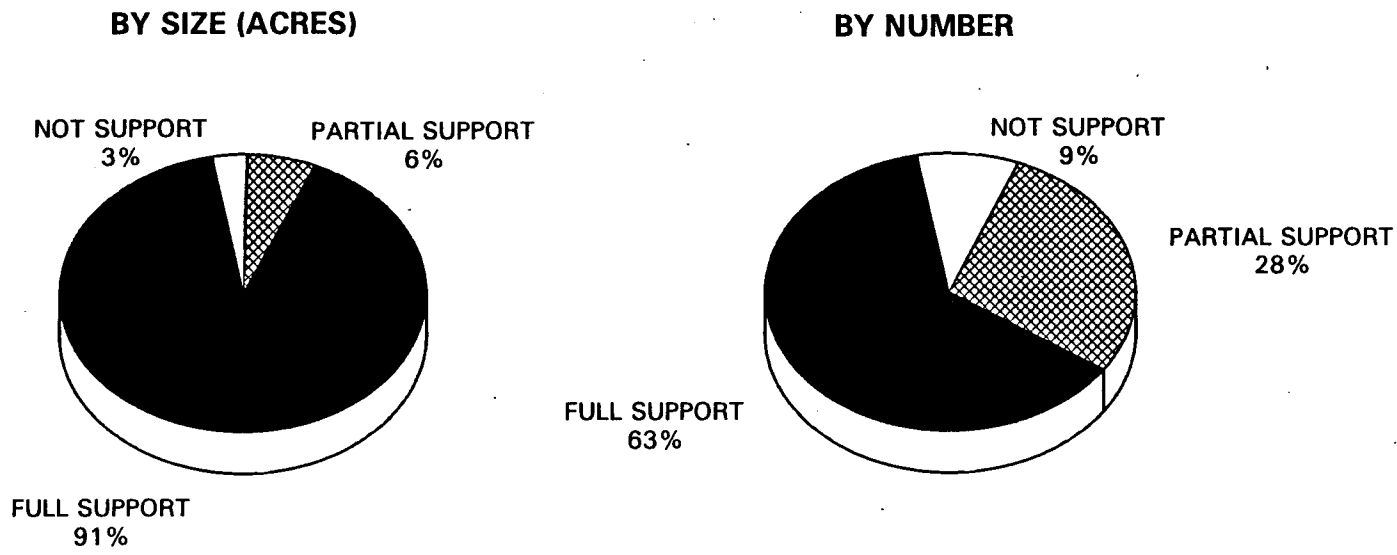
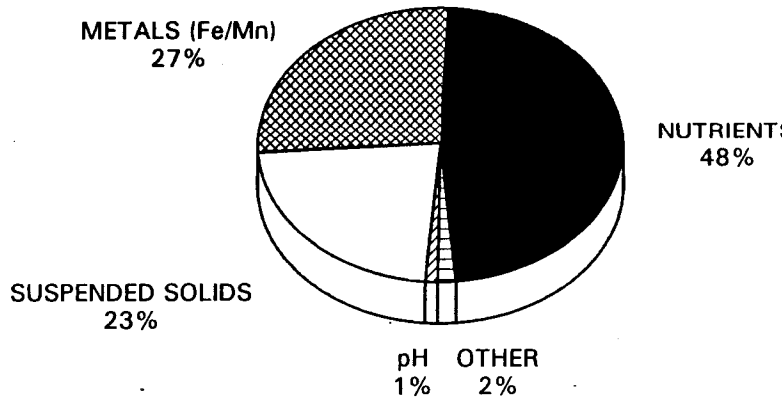


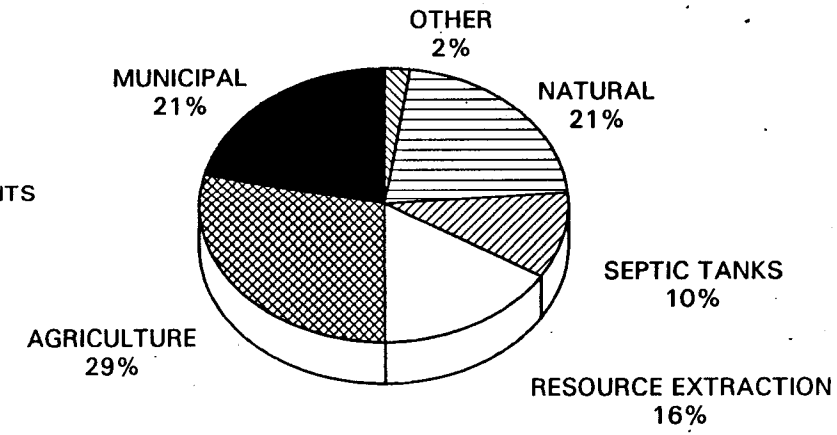
Figure V

USE NONSUPPORT IN LAKES BY SIZE (ACRES)

CAUSES



SOURCES



An analysis of lake trophic status indicated that of the 102 lakes assessed, 61 were eutrophic, 30 were mesotrophic, and 11 were oligotrophic. About half of the total lake acres were eutrophic. Of the rest, 30 percent were mesotrophic and 20 percent were oligotrophic (Figure VI). Green River and Nolin lakes became less eutrophic. Spurlington, Sympson, Campbellsville City, Jericho, Shelby (in Shelby County), Metcalfe County and Doe Run lakes became more eutrophic than previously reported. Briggs, Mauzy, and Herrington lakes were added to the list of lakes that did not support their uses. Reformatory Lake was removed from the list because water quality had improved to the point that it now partially supports the aquatic life use.

The envelope on the back inside cover of this report contains color coded maps of the degree of use support by major river basins for many streams and lakes in the state. Not all of the streams or lakes assessed are on the maps because of the limitation of the scale used.

Underground storage tanks, septic tanks, abandoned hazardous waste sites, agricultural activities, and landfills are estimated to be the top five sources of groundwater contamination in Kentucky. Improper well construction is no longer one of the top five priorities because new programs instituted by the Division ensure safe well construction standards. The major pollutant of groundwater was bacteria.

Lack of groundwater data, particularly on quality, quantity and availability and the potential for pesticides to pollute groundwater in karst regions, are two of the areas of special concern in the groundwater program.

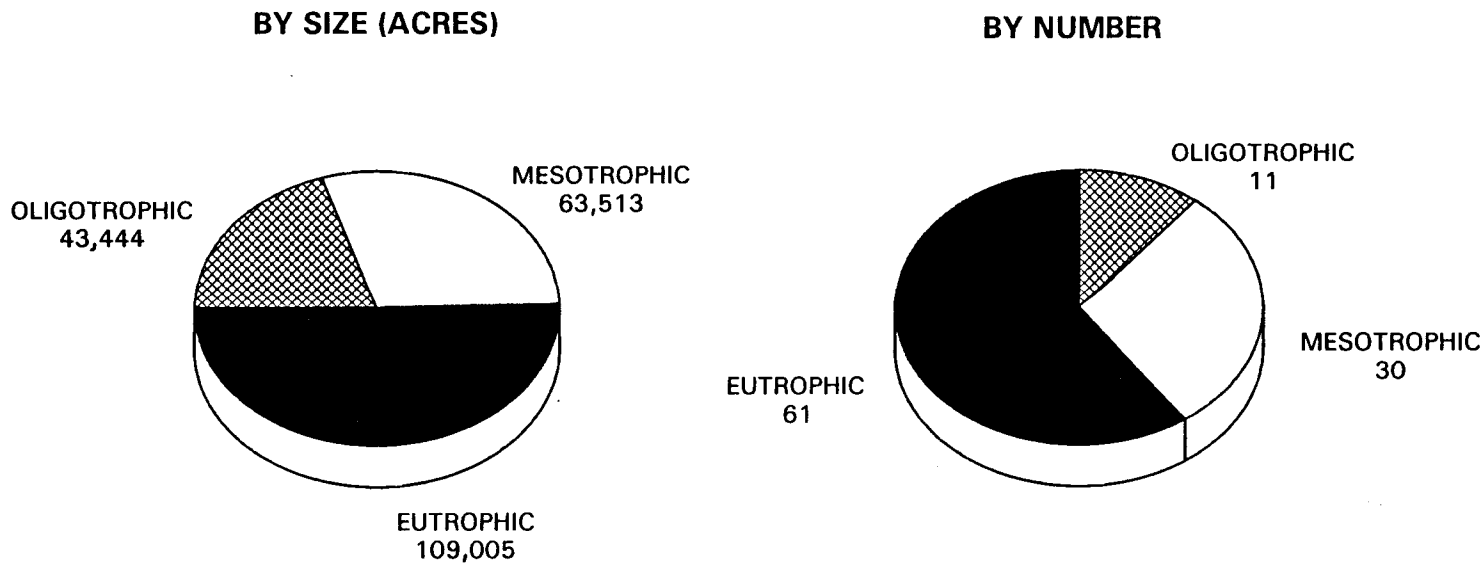
Water Pollution Control Programs

Kentucky's water pollution control programs continued expanding to develop new approaches for controlling pollution. By the end of 1991, 77 municipal and 35 industrial wastewater treatment facilities had KPDES permit requirements for whole effluent toxicity testing. The Division of Water conducted acute and chronic toxicity tests on 68 point source discharges in 1990 and 1991. A total of 1,212 tests were conducted by permitted facilities. Approximately one-third of the facilities with biomonitoring permit conditions are conducting toxicity reduction evaluations to reduce the toxicity of their effluents. Pretreatment programs have been approved in 69 cities to better treat industrial wastes. The cities of Louisville, Bardstown, Richmond, Leitchfield and Corbin won national awards in recognition of their effective and innovative pretreatment programs. A state revolving fund program was initiated to meet the needs of new wastewater treatment plant construction.

Forty-five primary ambient monitoring stations characterizing approximately 1,400 stream miles within the state, were in operation during the reporting period. Biological monitoring occurred at 18 of these stations during 1990 and 1991. In addition, six lakes were sampled for eutrophication trends and three lakes for acid

Figure VI

SUMMARY OF LAKE TROPHIC STATE



precipitation trends. Impacts from acid precipitation have not been detected. An expanded lake assessment project, funded by the federal Clean Lakes Program, allowed 50 additional lakes to be sampled for eutrophication trends. Five intensive surveys were conducted on 436 miles of streams for the evaluation of municipal point source and nonpoint agricultural pollution, to determine baseline water quality, and to evaluate the status of water quality in streams previously assessed. Results revealed that high nutrient concentrations impaired aquatic life use in South Elkhorn Creek near Lexington. Little Pitman Creek, near Campbellsville, had improved water quality, but was still impacted in the reach receiving municipal wastewater discharges.

WATER WATCH, a citizen's education program, expanded its membership and increased the number of waters "adopted" by local groups. Since its beginning, 345 groups have been established and 300 streams, 35 lakes, 30 wetlands, and nine karst or underground systems have been adopted. A water quality monitoring project produced data on stream water quality at 135 sites in seven of the twelve river basins in the state.

The nonpoint source control program is involved in monitoring projects in the Mammoth Cave area (Turnhole Spring Groundwater Basin), the upper Salt River/Taylorsville Lake watershed, and is participating with Tennessee agencies on an acid mine drainage project in the Bear Creek watershed, which originates in Tennessee, and drains into the Big South Fork of the Cumberland River in Kentucky. A new project is being initiated in the Fleming Creek watershed. These are long term studies to determine nonpoint source impacts and demonstrate water quality improvements from best management practices.

Education efforts in the program produced several noteworthy achievements. A slide/video program on pollution problems from nonpoint sources in Kentucky was produced under contract with Western Kentucky University. Funding was awarded to the Warren County Conservation District and the Gateway Region Environment-Education Network to develop nonpoint source education activities on ways to combat pollution from construction, urban runoff, agriculture, and septic systems.

An update of the Nonpoint Source Pollution Assessment Report was produced for this report. Streams, rivers, lakes, wetlands, and groundwater impacted by nonpoint sources of pollution are listed in an Appendix, along with current information regarding sources and parameters of concern.

BACKGROUND

BACKGROUND

This report was prepared to fulfill the requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500) as amended by the Clean Water Act of 1987 (P.L. 100-4). Section 305(b) requires that states submit a report to the U.S. Environmental Protection Agency (EPA) every two years that addresses current water quality conditions. This report generally assesses data collected in 1990 and 1991. Items to be addressed in the report include an assessment of the degree to which nonpoint sources of pollutants affect water quality, an assessment of state groundwater quality, an assessment of the extent to which the state's rivers, streams, and lakes meet their designated uses, and recommendations on additional actions that are necessary to achieve the water quality objectives of the Act. Specific data on lake water quality, and information on state programs is also required and addressed in the report. EPA uses the reports from the states to apprise Congress of the current water quality of the nation's waters and to recommend actions which are necessary to achieve improved water quality. States use the reports to provide information on water quality conditions to the general public and other interested parties, and to help set agency pollution control directions.

This report follows the guidance document that EPA provided to the states for the 1992 reporting period. The stream water quality in this report is based on those streams shown on the U.S. Geological Survey's (USGS) Hydrologic Unit Map of Kentucky (scale 1:500,000). The assessments were based on 1,467 streams and rivers composing over 18,000 stream miles (excluding the Ohio and Mississippi Rivers). Stream miles were determined by chord lengths to the 0.1 mile, on USGS 7.5 minute quadrangle maps (scale 1:24,000). These maps are the official river mile index maps maintained by the Division of Water. Stream miles not measured by this method were determined by using map wheels. The EPA has estimated river miles for states based on USGS 1:100,000 scale maps. This scale is recommended to be incorporated by states for 305(b) reporting purposes. Kentucky has followed this recommendation and now uses the EPA estimates and will eventually incorporate these streams and mileages into the assessment base. These estimates greatly expand the number and miles of streams and rivers used in 305(b) assessments. Previously, the total state miles in the assessment base were reported as 18,774. This is now increased to 55,306 miles. As a result, the miles assessed compared to the miles not assessed will be considerably less in this report (19 percent) than reported in 1990 (55 percent). The 55,306 miles contain 37,434 miles of perennial streams, 16,986 miles of intermittent streams and 886 miles of ditches and canals. According to these estimates, Kentucky ranks fourteenth in the nation in miles of perennial streams.

Kentucky is divided into 42 cataloging units, which comprise the 12 river basins assessed in this report. These drainage basins from east to west are the Big Sandy, Little Sandy, Tygarts, Licking, Kentucky, Upper Cumberland, Salt, Green, Tradewater, Lower Cumberland, Tennessee, and Mississippi. The Division of Water has subdivided the cataloging units into smaller, discrete, hydrologic units called waterbodies. The smaller

units are useful for assessment and management purposes. There are 759 waterbodies which include both rivers and lakes. Water quality assessment information on these waterbodies is stored by the Division in a computer software package created by EPA called the Waterbody System (WBS).

The assessment of lake conditions is based on data collected by the Division of Water in 1981-1983 and updated in 1989, 1990 and 1991 through a lake assessment project funded under the federal Clean Lakes Program. The 102 lakes that were assessed have a total area of 214,962 acres and comprise over 90 percent of the publicly owned lakes in the state. This includes the Kentucky portions of Barkley, Kentucky, and Dale Hollow lakes which are border lakes with Tennessee. The total lake acres is more than that estimated by EPA for Kentucky in their 1991 draft document Total State Waters: Estimating River Miles and Lake Acreages for the 1992 Water Quality Assessments (305(b) Reports). The estimates made by the Division are considered to be more accurate because they were taken from engineering drawings of impoundments in the Division's dam inventory files, which are made at a smaller scale, and are thus more accurate than the acreages on 7.5 minute quadrangle maps that were used by EPA. Estimates of major reservoirs were taken from U.S. Army Corps of Engineers reports and were based on acres at certain pool elevations which are also considered to be more accurate. An estimate of the number of lakes in the state was included in the above EPA document. It is based on those lakes shown on the 1:100,000 scale base map and separates lakes into three groups by size. According to those estimates, Kentucky has 2,374 lakes. Of the total, 1,678 are less than ten acres, 672 are between 10 and 500 acres, and 24 are greater than 500 acres. Total wetland acreage in Kentucky has not been accurately determined. The Division of Water, in collaboration with the Kentucky Department of Fish and Wildlife Resources (KDFWR), has contracted with the U.S. Fish and Wildlife Service to map wetlands in the Commonwealth. Estimates from this project are not yet available. The Kentucky State Nature Preserves Commission, in its 1986 report, Wetland Protection Strategies for Kentucky, estimated that 637,000 acres of wetlands remained in Kentucky as of 1978.

Kentucky's population, according to the 1990 census, is 3,685,296. The state has an approximate area of 40,598 square miles. It is estimated that there are approximately 89,431 miles of streams within the borders of Kentucky. That figure was determined from the Kentucky Natural Resources Information System, which has a computerized geographic database. All of the blue line streams on the 7.5 minute USGS topographic maps were digitized to produce the figure. Main channel and tributary river miles in reservoirs are included. A project is underway to subtract those miles, which will produce a more accurate river and stream mile total. Kentucky has 849 miles of border rivers. The northern boundary of Kentucky is formed by the low water mark of the northern shore of the Ohio River and extends along the river from Catlettsburg, Kentucky in the east, to the Ohio's confluence with the Mississippi River near Wickliffe in the west (a length of 664 miles). The southern boundary is formed by an extension of the Virginia-North Carolina 1780 Walker Line which extends due west to the

Tennessee River. Following the acquisition of the Jackson Purchase in 1818, the 36°30' parallel was accepted as the southern boundary from the Tennessee River to the Mississippi River.

Kentucky's eastern boundary begins at the confluence of the Big Sandy River with the Ohio River at Catlettsburg and follows the main stem of the Big Sandy and Tug Fork southeasterly to Pine Mountain, for a combined length of 121 miles, then follows the ridge of the Pine and Cumberland mountains southwest to the Tennessee line. The western boundary follows the middle of the Mississippi River for a length of 64 miles and includes several of the islands in the Mississippi channel. A listing of the above information is provided below.

Atlas

State population (1990 census)	3,685,296
State surface area (square miles)	40,598
Number of major river basins	12
Number of total river miles*	89,431
Number of river miles in assessment base	55,306
Number of miles assessed	10,659
Number of river border miles (subset)	849
Number of lakes/reservoirs	2,374
Number assessed	102
Total acres of lakes/reservoirs	Unknown
Acres assessed	214,962
Wetland acres	637,000

*includes reservoir main channel and tributary channel miles

The climate of Kentucky is classified as continental temperate humid. Summers are warm and humid with an average temperature of 76°F, while winters are moderately cold with an average temperature of 34°F. Annual precipitation averages about 45 inches, but varies between 40 to 50 inches across the state. Maximum precipitation occurs during winter and spring with minimum precipitation occurring in late summer and fall.

Summary of Classified Uses

Kentucky lists waterbodies according to specific uses in its water quality standards regulations. These uses are Warmwater Aquatic Habitat, Coldwater Aquatic Habitat, Domestic Water Supply, Primary Contact Recreation, Secondary Contact Recreation and Outstanding Resource Waters. Those waters not specifically listed are classified (by default) for use as warmwater aquatic habitat, primary and secondary contact recreation, and domestic water supply. The domestic water supply use is applicable at points of

public and semipublic water supply withdrawals. The Division of Water adds waterbodies to the regulation list as an ongoing process in its revision of water quality standards. Intensive survey data and data from other studies, when applicable, are used to determine appropriate uses. Currently, 4,252.7 stream miles are listed as warmwater aquatic habitat, 400.8 miles as coldwater aquatic habitat, 427.9 miles as outstanding resource waters and 5,081.3 miles as primary and secondary contact recreation. By default, over 84,000 miles are classified for the uses of warmwater aquatic habitat, primary and secondary contact recreation and domestic water supply (if applicable). There are approximately 104 points where domestic water supply is withdrawn in streams, and 54 lakes are used for domestic water supply purposes. Twenty-eight lakes have been classified for specific uses in the water quality standards regulations.

CHAPTER 1

WATER QUALITY ASSESSMENT OF RIVERS AND STREAMS

WATER QUALITY ASSESSMENT OF RIVERS AND STREAMS

Status

Water quality conditions for rivers and streams in Kentucky are summarized by use support status in Table 1. The table indicates that of the 10,659 miles assessed, approximately 36 percent experienced some degree of use impairment, while 64 percent fully supported uses. These figures are similar to those reported in 1990. Approximately 19 percent of the 55,300 river miles in the new stream assessment base were assessed. The total miles in Table 1 reflect the streams and mileages in the old database and are mainly those streams found on USGS 1:500,000 scale maps. The total miles assessed were similar to those reported in the 1990 305(b) report. Corrections on stream lengths account for some of the differences and some new streams were added to the assessment.

Table 1
Designated Use Support by River Basin

Basin	Total Miles	Miles Assessed	Miles Fully Supporting Uses	Miles Partially Supporting Uses	Miles Not Supporting Uses
Big Sandy	1117.6	544.1	281.2	13.5	249.4
Little Sandy	364.0	197.0	102.6	31.8	62.6
Tygarts Creek	194.9	194.9	194.9	0.0	0.0
Licking	2009.3	1030.4	751.6	62.2	216.6
Kentucky	3438.4	1857.9	1192.9	179.9	485.1
Upper Cumberland	2188.7	1030.4	776.2	132.6	92.6
Salt	1577.7	1075.5	568.6	83.1	423.8
Green	3585.3	2172.8	1678.9	153.8	340.1
Tradewater	518.1	389.4	173.0	125.3	91.1
Lower Cumberland	658.7	446.7	325.5	100.2	21.0
Tennessee	386.4	128.1	87.2	21.5	19.4
Mississippi	560.9	190.5	106.0	82.1	2.4
Ohio (Minor Tribs.)	1423.7	766.2	611.8	73.8	80.6
Ohio (Mainstem)*	663.9	663.9	0.0	324.6	339.3
State Total	18,687.6	10,658.8	6850.4	1384.4	2424.0

*Assessment provided in ORSANCO 1992 305(b) report.

Methods of Assessment

Water quality data collected by the Kentucky Division of Water (DOW), Kentucky Division of Waste Management, Ohio River Valley Water Sanitation Commission (ORSANCO), U.S. Army Corps of Engineers, and the U.S. Geological Survey (USGS) were used to determine stream use support status. Other sources of information used in this determination include biological studies at fixed stations,

intensive surveys, and data supplied by the Kentucky Department of Fish and Wildlife Resources. The data were categorized as "monitored" or "evaluated." Monitored data were derived from site specific ambient surveys and were generally no more than five years old. In some instances where watershed conditions remained unchanged, monitored data over five years were still considered valid and were categorized as monitored. Evaluated data were from other sources or from ambient surveys that were conducted more than five years ago. The criteria for assessing this data to determine use support follow.

Water Quality Data

Chemical data collected by the DOW, ORSANCO, and the USGS at fixed stations were evaluated according to U.S. EPA guidelines for the preparation of this report. Water quality data were compared with their corresponding criteria as noted in Table 2. All of the criteria in the table, except fecal coliform, were used to assess warmwater aquatic habitat (WAH) use support. If none of the criteria for dissolved oxygen, un-ionized ammonia, temperature, or pH, collected during the period of October 1989 through September 1991, were exceeded in 10 percent or less of the measurements, the segment fully supported its use for WAH. Partial support was indicated if any one criterion for these parameters was exceeded 11-25 percent of the time. The segment was not supporting if any one of these criteria was exceeded greater than 25 percent of the time.

Data for mercury, cadmium, copper, lead, and zinc were analyzed for violations of acute criteria listed in state water quality standards using three years of data (from October 1988 through September 1991). The segment fully supported its use if no criteria were exceeded at stations with quarterly or less frequent sampling, or if only one violation occurred at stations with monthly sampling. The segment was not supporting if one or more exceedences were measured at quarterly or less frequently sampled stations, or two or more exceedences occurred at stations sampled monthly. These assessment criteria are different from the past 305(b) reports. They are more closely linked to the way state water quality criteria were developed. Acute criteria are meant to protect aquatic life if the criteria concentration is not exceeded more than once every three years on the average. The new measures of use support were developed by a joint USGS, state and EPA workgroup. It reviewed the previously used measures and felt that these changes were appropriate because they were more closely linked to the frequency and duration assumptions inherent in water quality criteria.

Fecal coliform data were used to indicate degree of support for primary contact recreation (swimming) use. Primary contact recreation was fully supported if the criterion was exceeded in 10 percent or less of the measurements, partially supported if the criterion was exceeded in 11-25 percent of the measurements, and not supported if the criterion was exceeded greater than 25 percent of the time. In addition, streams with pH below 6.0 units caused by acid mine drainage were judged to not support this use.

Domestic water supply use was not assessed because the use is applicable at points of withdrawal only and could not be quantified in the format required by the guidelines. In areas where both chemical and biological data were available, the biological data were generally the determinate factor for establishing warmwater aquatic habitat use support status. This is especially true when copper, lead and zinc criteria were contradicted by biological criteria. The Division made this decision in recognition of the natural ability of surface waters to sequester metals and make them less bioavailable and therefore less toxic.

Table 2
Physical and Chemical Parameters and Criteria
Used to Determine Use Support Status
at Fixed Stations

Parameter	Criterion	Source
Dissolved oxygen	<4.0 mg/l	KWQS[1]
Temperature	30°C	KWQS
pH	6 to 9 units	KWQS
Un-ionized ammonia	0.05 mg/l	KWQS
Mercury	2.4 ug/l	KWQS
Cadmium	Based on hardness[2]	KWQS
Copper	Based on hardness[3]	KWQS
Lead	Based on hardness[4]	KWQS
Zinc	Based on hardness[5]	KWQS
Fecal coliform	(May 1 thru Oct. 31) 400 colonies/100 ml	KWQS

1) Kentucky Water Quality Standards
2) Criterion = $e^{(1.128 \ln x - 3.828)}$ x = hardness in mg/l as $CaCO_3$
3) Criterion = $e^{(.9422 \ln x - 1.464)}$ x = hardness in mg/l as $CaCO_3$
4) Criterion = $e^{(1.273 \ln x - 1.460)}$ x = hardness in mg/l as $CaCO_3$
5) Criterion = $e^{(.8473 \ln x + .8604)}$ x = hardness in mg/l as $CaCO_3$

Fixed-Station Biological Data

Biological data for 1990-1991 were collected from 18 fixed monitoring network stations in nine drainage basins throughout the state. Algae, macroinvertebrates, and fish were collected, and several community structure and function metrics were analyzed for each group of organisms. These metrics were used to determine biotic integrity, water quality, and designated use support for each reach monitored. Expectations for metric

values are dependent upon stream size, ecological region, and habitat quality and were applied accordingly. Criteria for bioassessment of warmwater aquatic habitat (WAH) use support (Table 3) were based on these expectations. Bioassessments integrated data from each group of organisms, habitat data, known physical and chemical parameters, and professional judgement of aquatic biologists.

Algae. Algal samples were collected from each biological monitoring station using both artificial substrates (for biomass estimates) and natural substrates (for algal identification and relative abundance). The condition of the algal community was determined by a periphyton biotic index (PBI) which includes the following metrics: total number of diatom species, diversity, pollution tolerance index, relative abundance of sensitive species, relative abundance of non-diatom algae, and biomass (chlorophyll α and ash-free dry-weight). The PBI is used to rank algal communities as excellent or good (supporting WAH uses), fair (partially supporting), or poor (not supporting).

Macroinvertebrates. Macroinvertebrates were collected using both artificial substrates and qualitative collections from all available natural substrate habitats. For the macroinvertebrate evaluations, stream reaches were considered to fully support the WAH use if information reflected no alterations in community structure or functional compositions for the available habitats, and if habitat conditions were relatively undisturbed. A reach was considered partially supporting uses when information revealed that community structure was slightly altered, that functional feeding components were noticeably influenced, or if available habitats reflected some alterations and/or reductions. Reaches were considered not supporting uses if information reflected sustained alterations or deletions in community structure, taxa richness and functional feeding types, or if available habitats were severely reduced or eliminated.

Fish. Fish were collected for community structure evaluation at the biological monitoring sites listed in Table 45. The condition of the fish community was determined by analysis of species richness, relative abundance, species composition, and with the Index of Biotic Integrity (IBI). The IBI was used to assess biotic integrity directly by evaluation of twelve attributes, or metrics, of fish communities in streams. These community metrics include measurement of species richness and composition, trophic structure, and fish abundance and condition. The IBI was used to assign one of the following categories to a fish community: excellent, good, fair, poor, very poor, or no fish. Reaches with an IBI of excellent or good were considered to fully support uses. Reaches were evaluated as partially supporting uses if they had an IBI of fair, while reaches were considered not supporting uses when the IBI category was poor, very poor, or no fish.

Table 3
Biological Criteria for Assessment of
Warmwater Aquatic Habitat (WAH) Use Support

	Fully Supporting	Partially Supporting	Not Supporting
Algae	Taxa richness (TR) high, intolerant taxa present, community similarity to reference site $\geq$50%, biomass similar to reference/control or STORET mean.	Reduced number or Relative Abundance (RA) of intolerant taxa, community similarity to reference site lower than 50%, increased RA of pollution tolerant taxa, increased biomass (if nutrient enriched) of filamentous green algae.	Low TR, loss of sensitive species, pollution tolerant taxa dominant, low community similarity to reference sites, biomass very low (toxicity) or high (organic enrichment).
Macroinvertebrate	Taxa richness, functional grouping and EPT* index high, community similarity to reference site >50%, sensitive species present.	Taxa richness and/or EPT lower than expected in relation to available habitat. Community similarity to reference site <50%, increased RA or numbers of facultative taxa. Reduction in RA of sensitive taxa. Some alterations of functional groups evident.	Taxa richness and EPT low, community similarity low, facultative or pollution tolerant taxa dominant, TNI* of tolerant taxa very high. Most functional groups missing from community.
Fish	Index of Biotic Integrity (IBI) excellent or good, presence of rare, endangered or species of special concern.	IBI fair	IBI poor, very poor, or no fish.

*EPT - Ephemeroptera, Plecoptera, Trichoptera, TNI - Total Number of Individuals

Intensive Survey Data

In the 1990-1991 biennium, five intensive surveys were conducted to determine if target streams were supporting their designated uses. Data were also evaluated for 45 additional surveys conducted between 1982 and 1989. Streams intensively surveyed more than five years ago are considered as "evaluated waters," whereas streams surveyed more recently are "monitored waters."

The streams were assessed by evaluating the biological communities (refer to Table 3), physicochemical, toxicity, and habitat data, as well as known watershed activities in concert with direct observation and professional judgement. Stream mileages were grouped as supporting, partially supporting, or nonsupporting designated uses. Streams are considered to support designated uses if no impacts, or only minor impacts to the biotic integrity, physical habitat, and water quality are observed. Streams are determined to be partially supporting when the data indicate either stressed biotic communities, minor violations of water quality criteria, or some physical impairment to aquatic habitats. Nonsupporting streams are those showing sevére stress, such as sustained species deletions, trophic imbalances in the biotic communities, chronic violations of water quality criteria, and severely impaired aquatic habitats.

Kentucky Department of Fish and Wildlife Resources Data

The Division of Water extended its analysis of stream use support for the 1990 305(b) report by developing questionnaires on unmonitored streams and sending them to Conservation Officers of the Kentucky Department of Fish and Wildlife Resources (KDFWR). The responses were classified as evaluated assessments. Each questionnaire was divided into two sections. A habitat evaluation section included questions on major land uses in the stream basin, flow, bottom type, sedimentation, and water quality. A fisheries support section was evaluated through questions regarding stream fishery characterization, reproduction (as indicated by presence or absence of both young-of-year (y-o-y) and adult sport fishes), fishery success, and trend of the fishery over the last 10 years. If the fishery was felt to be poor, the respondent was asked to indicate why.

In this assessment of use support, only those questionnaire responses indicating definite support or nonsupport were used. Partial support was not assessed. A stream was considered to fully support WAH use if:

(1) the stream supported a good fishery,
(2) both y-o-y and adult sport fishes were present, or if only y-o-y were present, the stream was a tributary to a stream supporting the WAH use, and
(3) water quality was judged good.

A stream did not support the WAH use if:

(1) the stream supported a poor fishery,
(2) few or no fish were present in the stream, and
(3) water quality was judged poor and/or repeated fish kills were known to occur.

Another source of data for the evaluated category was a list of streams recommended by the KDFWR as candidates for State Outstanding Resource Waters. They were recommended because of their outstanding value as sport fishing streams. These streams were assessed as fully supporting warmwater aquatic habitat use if there was no data which conflicted with the assessment. The above evaluations were utilized again in this report.

Other Data Sources

The classification of streams as coldwater aquatic habitats (CAH) in Kentucky's water quality standards regulations are established from data provided by the KDFWR. Their field surveys indicate which streams can support a sustainable year-round trout fishery. These streams were considered to fully support their CAH use and were considered as monitored waters in the assessment.

The USGS and the Louisville and Jefferson County Metropolitan Sewer District have a monitoring program for several streams in Jefferson County. Twenty-six stations are monitored for 44 parameters including fecal coliform bacteria. Macroinvertebrate and fish collections are also made. The Division used the chemical and bacteriological data from 1989 and 1990 for this report and considered it as monitored data in the assessments.

Field work conducted for the U.S. Fish and Wildlife Service identified streams in Kentucky that harbored the blackside dace, a federally threatened species of fish. This work was considered as monitored data. These streams are automatically classified as State Outstanding Resource Waters and were judged to fully support the WAH use.

Streams surveyed by the Kentucky State Nature Preserves Commission for a special project to obtain background aquatic biota and water quality data in the oil shale region of the state were utilized as monitored information in this report. The information was published in a 1984 report entitled Aquatic Biota and Water Quality and Quantity Survey of the Kentucky Oil Shale Region.

The Blaine Creek watershed has been monitored by the U.S. Army Corps of Engineers - Huntington District for several years in conjunction with the Yatesville Lake project. Their macroinvertebrate and chemical data were utilized as monitored information for this report.

Fish Consumption Use Support

Fish consumption is a new category of use which replaces the assessment of waters meeting the fishable goal of the Clean Water Act. States were not consistent in assessing the fishable goal in previous reports. Some reported that the fishable goal was met if the fish community was healthy even though there was a fish consumption advisory in effect. Other states reported the opposite. Separating fish consumption and aquatic life use gives a clearer picture of actual water quality conditions.

The following criteria were used to assess support for the fish consumption use.

- Fully Supporting: No fish advisories or bans in effect.
- Partially Supporting: "Restricted consumption" fish advisory or ban in effect for general population or a subpopulation that could be at potentially greater risk (e.g., pregnant women, children). Restricted consumption is defined as limits on the number of meals consumed per unit time for one or more fish species.
- Not Supporting: "No consumption" fish advisory or ban in effect for general population, or a subpopulation that could be at potentially greater risk, for one or more fish species; commercial fishing ban in effect.

<u>Use Support Summary</u>

Table 4 shows the results of the evaluated and monitored use assessments from DOW data. Table 1 has more total assessed miles and more miles in the partial support category because it included conclusions from ORSANCO's assessment of the mainstem of the Ohio River and Missouri's assessment of the Mississippi River. Both tables follow EPA guidelines which define fully supporting as meaning that all uses that were assessed, had to be fully supporting before a segment could be listed under that title. If a segment supported one use, but did not support another, it was listed as not supporting. For instance, if a segment supported a warmwater aquatic habitat use, but not a primary contact recreation use, it was listed as not supporting. A segment is listed as partially supporting if any assessed use fell into that category even if another use was fully supported. Many streams were assessed for only one use because data were not available to assess other uses. Table 5 is a summary of individual use support.

The threatened category refers to stream miles that were judged to be in danger of use impairment from anticipated land use changes or development of trends indicating possible impairment. The aquatic life use of four streams was judged to be threatened by siltation from silvicultural activities (Rockcastle River, Horselick Creek, Raccoon

Creek, and White Oak Creek). Illwill Creek's aquatic life use is threatened by petroleum activities and the aquatic life use in the Salt River above Taylorsville Lake is threatened by nutrients from feedlots.

Sixty-eight percent of the assessed waters fully supported their uses. Twenty-one percent (2085 miles) did not support either aquatic life uses and/or swimming uses. Ten percent of the assessed rivers and streams partially supported these uses. The use most impaired was swimming. Close to half of the waters assessed for swimming did not support that use (1589 miles). In contrast, aquatic life use was fully supported in 79 percent (7192 miles) of the waters assessed for that use. Twelve percent were partially supported (1129 miles) and the use was not supported in nine percent (780 miles) of the assessed waters.

Table 4
Summary of Assessed* Use Support

Degree of Use Support	Assessment Basis: Evaluated	Assessment Basis: Monitored	Total Assessed
Miles Fully Supporting	4024.0	2562.7	6586.7
Miles Fully Supporting but Threatened	0.0	68.8	68.8
Miles Partially Supporting	225.6	770.2	995.8
Miles Not Supporting	319.1	1765.6	2084.7
TOTAL	4568.7	5167.3	9736.0

*Excludes mainstems of Ohio and Mississippi rivers; refer to ORSANCO and Missouri 305(b) reports for assessments.

Table 5
Summary of Individual Use Support for Rivers and Streams (in miles)

	Fish Consumption	Aquatic Life	Swimming
Total Assessed	9173.6	9173.6	3397.4
Supporting	9048.7	7192.1	1543.0
Threatened	0.0	72.3	0.0
Partially Supporting	0.0	1128.9	265.4
Not Supporting	124.9	780.3	1589.0

Causes of Use Nonsupport

Table 6 indicates the relative causes of use nonsupport. Stream segment lengths that either did not support or partially supported uses were combined to indicate the miles that were affected. Fecal coliform bacteria (pathogen indicators) were the greatest cause of use impairment and affected swimming use in 1585 miles of streams and rivers. Siltation was the second greatest cause of use impairment, impairing aquatic life use in 812 miles of streams and rivers and moderately impacting an additional 108 miles. Siltation affects the use by covering available habitat, preventing aquatic organisms from inhabiting streams that could normally support them. Organic enrichment was the third leading cause of use impairment. Organic enrichment lowers dissolved oxygen in streams, which causes stress on aquatic life. Aquatic life use was impaired in 547 miles of streams because of organic enrichment effects.

Sources of Use Nonsupport

Sources of use nonsupport were assessed under point and nonpoint categories and are listed in Table 7. Results were similar to the findings in the 1990 305(b) report. Nonpoint sources as a whole affected about twice as many miles of streams as point sources.

Municipal point sources and agricultural nonpoint sources were the leading sources of use nonsupport, each affecting over 1000 miles of streams. Swimming was the major use impaired by municipal sources and was caused by fecal coliform pollution. Nutrients from municipal sources also impaired aquatic life use.

Agriculture affected warmwater aquatic habitat use because of siltation and nutrients and primary contact recreation use because of fecal coliform contamination. Resource extraction activities relating to coal mining and petroleum production were the third leading source of use impairment. Siltation from coal mining and chlorides from petroleum sources impaired aquatic life uses.

Rivers and Streams Not Supporting Uses

Table 8 lists streams and rivers which did not support warmwater aquatic habitat (denoted as aquatic life) and swimming uses. Stream miles affected and causes and sources of nonsupport are also listed. The table differs from a similar table in the 1990 305(b) report by not including streams and rivers in the partial support category. The waters in Table 8 are the most impaired rivers and streams in the state.

Table 6
Causes of Use Nonsupport in Rivers and Streams

Cause Category	Miles Affected: Major Impact	Miles Affected: Moderate/Minor Impact
Pathogen indicators	1585.3	4.8
Siltation	812.3	108.5
Organic enrichment/D.O.	546.9	56.4
Nutrients	269.9	91.5
pH	258.6	15.1
Metals	194.4	18.1
Salinity/TDS/Chlorides	178.2	20.1
Priority organics	144.3	24.3
Unknown toxicity	116.0	0.0
Habitat alterations	98.3	24.3
Oil and grease	36.1	0.0
Suspended solids	32.3	4.2
Other	5.3	0.0

Table 7
Sources of Use Nonsupport in Rivers and Streams

Source Category	Miles Affected: Major Impact	Miles Affected: Moderate/Minor Impact
Point Sources		
Municipal	1583.5	165.0
Industrial	180.5	25.4
Combined sewer overflows	23.6	0.0
TOTAL	1787.6	190.4
Nonpoint Sources		
Agriculture	1330.5	476.9
Resource extraction	1078.0	51.2
Urban Runoff/Storm sewers	325.0	73.3
Hydro-Habitat modification	110.1	68.6
Land disposal/septic tanks	64.6	126.7
Construction	2.5	0.0
Silviculture	0.0	34.3
TOTAL	2910.7	831.0
Unknown	333.9	18.1

Table 8
List of Streams Not Supporting Uses by River Basin

Stream (Waterbody (I.D.)		Uses Not Supported: Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Big Sandy River Basin							
Tug Fork	(KY5070201-001) (KY5070201-004)				57.9	Pathogens	Municipal/ Agriculture
Big Creek	(KY5070201-005)	19.7	Siltation	Agriculture/ Mining			
Knox Creek	(KY5070201-010)				7.6	Pathogens	Agriculture
Levisa Fork	(KY5070202-001) (KY5070203-010) (KY5070203-016) (KY5070203-021)				49.5	Pathogens	Municipal/ Agriculture
Shelby Creek	(KY5070202-002)				10.0	Pathogens	Municipal
Russell Fork	(KY5070202-004)				16.0	Pathogens	Municipal/ Agriculture
Elkhorn Creek	(KY5070202-005)				27.4	Pathogens	Municipal
Paint Creek	(KY5070203-005)				1.0	Pathogens	Urban Runoff/ Storm Sewers
Left Fork Middle Creek	(KY5070203-014)	9.5	pH	Mining	9.5	pH	Mining
Beaver Creek	(KY5070203-018)				7.0	Pathogens	Municipal
Mud Creek	(KY5070203-022)	17.0	Siltation/Organic Enrichment	Agriculture/ Mining			
Big Sandy	(KY5070204-001)	26.8	Metals	Unknown	26.8	Pathogens	Municipal/ Agriculture

Table 8 (Continued)

Stream (Waterbody (I.D.)		Uses Not Supported: Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Little Sandy River Basin							
Little Sandy River	(KY5090104-004)				39.3	Pathogens	Municipal/ Agriculture/ Septic tanks
East Fork Little Sandy River	(KY5090104-003)	6.0	Organic Enrichment	Municipal			
Shope Creek	(KY5090104-003)	5.4	Organic Enrichment	Municipal			
Newcombe Creek	(KY5090104-009)	11.9	Chlorides	Petroleum Activities			
Licking River Basin							
Licking River	(KY5100101-001) (KY5100101-004) (KY5100101-034)	6.3	Metals	Unknown	56.4	Pathogens	Municipal/ Agriculture/ Combined Sewer Overflows
North Fork Licking River	(KY5100101-012)				19.5	Pathogens	Agriculture
Banklick Creek	(KY5100101-002)				19.0	Pathogens	Combined Sewer Overflows
Three-Mile Creek	(KY5100101-003)				4.7	Pathogens	Urban Runoff/ Storm Sewers
Lick Creek	(KY5100101-037)	9.2	Chlorides	Petroleum Activities			
Raccoon Creek	(KY5100101-037)	5.2	Chlorides	Petroleum Activities			

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Licking River Basin (Continued)							
Burning Fork	(KY5100101-038)	7.5	Chlorides	Petroleum Activities			
State Road Fork	(KY5100101-038)	5.1	Chlorides	Petroleum Activities			
Rockhouse Fork	(KY5100101-038)	5.0	Chlorides	Petroleum Activities			
Indian Creek	(KY5100102-009)				0.6	Pathogens	Municipal
Stoner Creek	(KY5100102-012)				9.6	Pathogens	Municipal/ Agriculture
Houston Creek	(KY5100102-013)				14.0	Pathogens	Agriculture
Hancock Creek	(KY5100102-017)				7.6	Pathogens	Agriculture
Strodes Creek	(KY5100102-017)				26.5	Pathogens	Municipal/ Agriculture/ Urban Runoff/ Storm Sewers
Brushy Fork	(KY5100102-020)	5.0	Nutrients/ Chlorides	Industrial			
U.T. to Brushy Fork	(KY5100102-020)	0.2	Nutrients/ Chlorides	Industrial			
Hinkston Creek	(KY5100102-024)				19.8	Pathogens	Municipal/ Agriculture

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Kentucky River Basin							
North Fork Kentucky River	(KY5100201-002) (KY5100201-005) (KY5100201-008)				55.1	Pathogens	Municipal/ Urban Runoff/ Storm Sewers
Quicksand Creek	(KY5100201-007)				20.8	Pathogens	Agriculture
South Fork Quicksand Creek	(KY5100201-007)				13.8	Pathogens	Agriculture
Spring Fork Quicksand Creek	(KY5100201-007)	15.0	Siltation	Mining			
Lost Creek	(KY5100201-009)	18.5	Siltation	Mining			
Troublesome Creek	(KY5100201-009)				49.5	Pathogens	Municipal/Land Disposal
Rockhouse Creek	(KY5100201-021)	24.3	Siltation	Mining			
Cutshin Creek	(KY5100202-006)	28.8	Oil and Grease/ Siltation	Petroleum Activities/Mining			
Raccoon Creek	(KY5100202-006)	7.3	Oil and Grease/ Siltation	Petroleum Activities/Mining			
Billey Fork	(KY5100204-009)	8.1	Chlorides	Petroleum Activities			
Millers Creek	(KY5100204-009)	6.4	Chlorides	Petroleum Activities			
Big Sinking Creek	(KY5100204-009)	14.1	Chlorides	Petroleum Activities			
Red River	(KY5100204-013)	10.0	Metals	Unknown	10.0	Pathogens	Municipal

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Kentucky River Basin (Continued)							
South Fork Red River	(KY5100204-018)	10.1	Chlorides	Petroleum Activities			
Sand Lick Creek	(KY5100204-018)	5.0	Chlorides	Petroleum Activities			
Cat Creek	(KY5100204-017)	7.7	Organic Enrichment/ Metals	Source Unknown			
Eagle Creek	(KY5100205-003) (KY5100205-005)				38.8	Pathogens	Source Unknown
Kentucky River - Lockport	(KY5100205-011)				40.9	Pathogens	Source Unknown
Kentucky River - Boonesboro	(KY5100205-047)				32.7	Pathogens	Source Unknown
Elkhorn Creek	(KY5100205-018)				17.8	Pathogens	Source Unknown
North Elkhorn Creek	(KY5100205-022)	2.0	Organic Enrichment/ Chlorine	Municipal			
Dry Run	(KY5100205-023)				7.5	Pathogens	Municipal/ Agriculture
U.T. to North Elkhorn Creek	(KY5100205-025)				10.8	Pathogens	Agriculture
South Elkhorn Creek	(KY5100205-026)				17.6	Pathogens	Urban Runoff/ Storm Sewers
Lee Branch	(KY5100205-027)	1.0	Organic Enrichment	Municipal			

Table 8 (Continued)

Stream (Waterbody (I.D.)		Uses Not Supported: Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Kentucky River Basin (Continued)							
Town Branch	(KY5100205-028)	11.3	Organic Enrichment/ Metals/ Nutrients	Municipal			
Clarks Run	(KY5100205-039)	8.0	pH/Organic Enrichment	Municipal			
Silver Creek	(KY5100205-052)	2.0	Organic Enrichment/ Nutrients	Municipal			
Brushy Fork	(KY5100205-052)	0.2	Nutrients	Municipal			
Green River Basin							
Nolin River	(KY5110001-010)				49.2	Pathogens	Municipal
Valley Creek	(KY5110001-012)	17.5	Organic Enrichment/ Chlorides	Municipal/ Urban Runoff/ Storm Sewers			
Doty Creek	(KY5110002-012)				4.0	Pathogens	Pasture Land/ Feedlots/ Animal Holding/ Mgt. Areas
Patoka Creek	(KY5110002-018)				4.3	Pathogens	Pasture Land/ Feedlots/ Animal Holding/ Mgt. Areas
Pond Creek	(KY5110003-003)	23.8	pH/Metals	Mining	23.8	pH	Mining

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Green River Basin (Continued)							
Mud River	(KY5110003-005) (KY5110003-008)	64.8	Priority Organics/ Organic Enrichment	Industrial/ Unknown			
Green River	(KY5110005-001) (KY5110005-003) (KY5110005-011)				55.1	Pathogens	Agriculture/ Urban Runoff/ Storm Sewers
Cypress Creek	(KY5110006-002)	33.3	pH	Mining	33.3	pH	Mining
Harris Branch	(KY5110006-002)	2.6	pH	Mining	2.6	pH	Mining
Flat Creek	(KY5110006-005)	10.6	pH	Mining	10.6	pH	Mining
Drakes Creek	(KY5110006-006)	21.3	pH	Mining	21.3	pH	Mining
Upper Cumberland River Basin							
Cumberland River	(KY5130101-025) (KY5130101-032)				41.1	Pathogens	Municipal/ Land Disposal
Yellow Creek	(KY5130101-031)				9.5	Pathogens	Municipal
Cranks Creek	(KY5130101-038)	15.1	Siltation/pH	Mining			
Big Lily Creek	(KY5130103-011)	2.6	Chlorides	Industrial			
Elk Spring Creek	(KY5130103-018)	1.5	Organic Enrichment	Municipal			
Rock Creek	(KY5130104-007)	4.0	Metals/pH	Mining	4.0	pH	Mining
Roaring Paunch Creek	(KY5130104-008)	15.6	pH	Subsurface Mining/Surface Mining			

Table 8 (Continued)

Stream (Waterbody (I.D.)		Uses Not Supported: Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Upper Cumberland River Basin (Continued)							
Bear Creek	(KY5130104-009)	3.2	pH	Subsurface Mining/Surface Mining	3.2	pH	Surface Mining/ Subsurface Mining
Lower Cumberland River Basin							
North Fork Little River (inc. Upper Branch)	(KY5130205-009)				18.1	Pathogens	Municipal/ Agriculture
Elk Fork	(KY5130206-002)	7.0	Organic Enrichment	Municipal/ Agriculture			
Salt River Basin							
Pond Creek	(KY5140102-002)	17.0	Unknown Toxicity/ Organic Enrichment/ Metals	Municipal	17.0	Pathogens	Municipal
Northern Ditch Pond Creek (inc. Fern Creek)	(KY5140102-002)	10.1	Unknown Toxicity/ Organic Enrichment/ Metals	Municipal	10.1	Pathogens	Municipal
Southern Ditch Pond Creek	(KY5140102-002)	7.1	Unknown Toxicity/ Organic Enrichment/ Metals	Municipal	7.1	Pathogens	Municipal

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Salt River Basin (Continued)							
Spring Ditch	(KY5140102-002)	2.0	Unknown Toxicity/ Organic Enrichment/ Metals	Municipal	2.0	Pathogens	Municipal
Fishpool Creek	(KY5140102-002)	5.4	Unknown Toxicity/ Organic Enrichment	Municipal	5.4	Pathogens	Municipal
Knob Creek	(KY5140102-002)	15.3	Unknown Toxicity/ Organic Enrichment	Municipal			
Briar Creek	(KY5140102-002)	5.7	Unknown Toxicity/ Organic Enrichment	Municipal			
Mill Creek	(KY5140102-003)				13.5	Pathogens	Municipal
Salt River	(KY5140102-005) (KY5140102-029) (KY5140102-031)				57.5	Pathogens	Septic Tanks/ Urban Runoff/ Storm Sewers/ Municipal/ Pasture Land/ Feedlots/ Animal Holding/ Mgt. Areas

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Salt River Basin (Continued)							
Town Creek	(KY5140102-033)				3.2	Pathogens	Municipal/ Pasture Lands/ Feedlots/ Animal Holding/ Mgt. Areas
Floyds Fork	(KY5140102-007) (KY5140102-011) (KY5140102-014)	13.0	Organic Enrichment	Municipal/ Urban Runoff/ Storm Sewers/ Flow Regulation	61.6	Pathogens	Municipal
Cedar Creek	(KY5140102-008)	15.2	Organic Enrichment	Municipal	15.2	Pathogens	Municipal
Pennsylvania Run	(KY5140102-008)				5.5	Pathogens	Municipal
Brooks Run	(KY5140102-009)	6.0	Organic Enrichment	Municipal	6.0	Pathogens	Municipal
Chenoweth Run	(KY5140102-010)	9.1	Organic Enrichment	Municipal	9.1	Pathogens	Municipal
Pope Lick Creek	(KY5140102-012)				5.0	Pathogens	Municipal/ Urban Runoff/ Storm Sewers
Long Run	(KY5140102-012)				9.5	Pathogens	Municipal/ Agriculture

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Salt River Basin (Continued)							
Beech Creek	(KY5140102-026)				30.1	Pathogens	Pasture Lands/ Feedlots/ Manure Lagoons/ Animal Holding/ Mgt. Areas/ Septic Tanks
Crooked Creek	(KY5140102-027)				13.9	Pathogens	Pasture Land/ Feedlots/ Septic Tanks/ Animal Holding/ Mgt. Areas
Ashes Creek	(KY5140102-028)				10.3	Pathogens	Pasture Land/ Feedlots/ Animal Holding/ Mgt. Areas
Jacks Creek	(KY5140102-028)				8.0	Pathogens	Pasture Land/ Feedlots/ Manure Lagoons/ Animals Holding/ Mgt. Areas

Table 8 (Continued)

Stream (Waterbody (I.D.)		Uses Not Supported: Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Salt River Basin (Continued)							
Timber Creek	(KY5140102-028)				4.8	Pathogens	Pasture Land/ Feedlots/ Manure Lagoons/ Animals Holding/ Mgt. Areas
Rolling Fork	(KY5140103-001) (KY5140103-005)				107.4	Pathogens	Municipal/ Agriculture
Tradewater River Basin							
Crab Orchard Creek	(KY5140205-003)	22.6	pH/Siltation	Mining/ Agriculture	22.6	pH	Mining
Vaughn Ditch	(KY5140205-003)	3.2	pH/Siltation	Mining/ Agriculture	3.2	pH	Mining
Clear Creek	(KY5140205-008)	28.1	pH/Siltation	Mining/ Agriculture	28.1	pH	Mining
Lick Creek	(KY5140205-008)	18.1	pH/Siltation	Mining/ Agriculture	18.1	pH	Mining
Caney Creek	(KY5140205-015)	11.3	pH/Siltation	Mining/ Agriculture	11.3	pH	Mining
Buffalo Creek	(KY5140205-016)	7.8	pH/Siltation	Mining/ Agriculture	7.8	pH	Mining

Table 8 (Continued)

Uses Not Supported

Stream (Waterbody (I.D.)		Aquatic Life (miles)	Cause	Source	Swimming (miles)	Cause	Source
Tennessee River Basin							
Cypress Creek	(KY6040006-013)	19.4	Unknown Toxicity/ Priority Organics	Industrial			
Mississippi River Basin							
Mayfield Creek	(KY8010201-004)	2.4	Organic Enrichment	Municipal			
Ohio River Tributaries							
Muddy Fork Beargrass Creek	(KY5140101-002)				6.9	Pathogens	Municipal/Urban Runoff/ Storm Sewers
South Fork Beargrass Creek	(KY5140101-002)				14.6	Pathogens	Municipal/Urban Runoff/ Storm Sewers
Middle Fork Beargrass Creek	(KY5140101-002)	2.5	Organic Enrichment	Urban Runoff/ Storm Sewers	15.2	Pathogens	Municipal/Urban Runoff/ Storm Sewers
Goose Creek	(KY5140101-003)				12.2	Pathogens	Municipal
Little Goose Creek	(KY5140101-003)				8.7	Pathogens	Municipal
Little Bayou Creek	(KY5140206-002)	6.5	Priority Organics	Hazardous Waste			
Mill Creek	(KY5140101-001)	16.5	Metals	Urban Runoff/ Storm Sewers	16.5	Pathogens	Urban Runoff/ Storm Sewers

Changes in Use Support: 1990 to 1992

Several waterbodies showed an improvement in water quality since the last report. Consequently, their use support status has changed. The streams listed in Table 9 as fully supporting a use had previously been assessed as either not supporting or partially supporting aquatic life or swimming uses.

Table 9 also lists waterbodies that have poorer water quality than that reported in 1990. Their use has either changed from full support or partial support to not support.

Blaine Creek water quality has improved because of the shut-down of oil and gas production in its watershed. The changes to full support of aquatic life in the Green River at Sebree and the Barren River near Bowling Green, and not support in the Big Sandy near Louisa, Licking River near Covington, and Red River near Clay City is a reflection of the change in the criteria used in the assessments and not a change in water quality. The changes in swimming use support are probably most related to differing rainfall patterns between the years as fecal coliform contamination has been positively linked to rain events.

Trends in Water Quality

A statistical trend analysis was not performed in this reporting period. A trend analysis is reported every four years. However, a noteworthy change in water quality was detected at monitoring stations on the Kentucky and Licking Rivers and will be discussed. Brine pollution of streams and rivers from oil and gas production operations has been a concern in Kentucky for several years. Steps were taken in 1985 to add chloride to Kentucky's water quality criteria to protect aquatic life. That enabled the Division to limit chlorides on permits for oil and gas production facilities. Since that time monitoring of water quality in the affected areas of the Kentucky River, Blaine Creek, and Licking River basins has shown a decrease in chloride concentrations, particularly in 1989, 1990, and 1991. Figure 1 illustrates the decrease noted in the Kentucky River at the Heidelberg monitoring station. The decrease has also been noted farther down river at Camp Nelson and in the South Fork of the Kentucky River.

Blaine Creek water quality has improved as noted in the previous section. The Right and Left forks of Blaine Creek have improved water quality, but still show some signs of chloride impacts on macroinvertebrate communities and only partially support aquatic life.

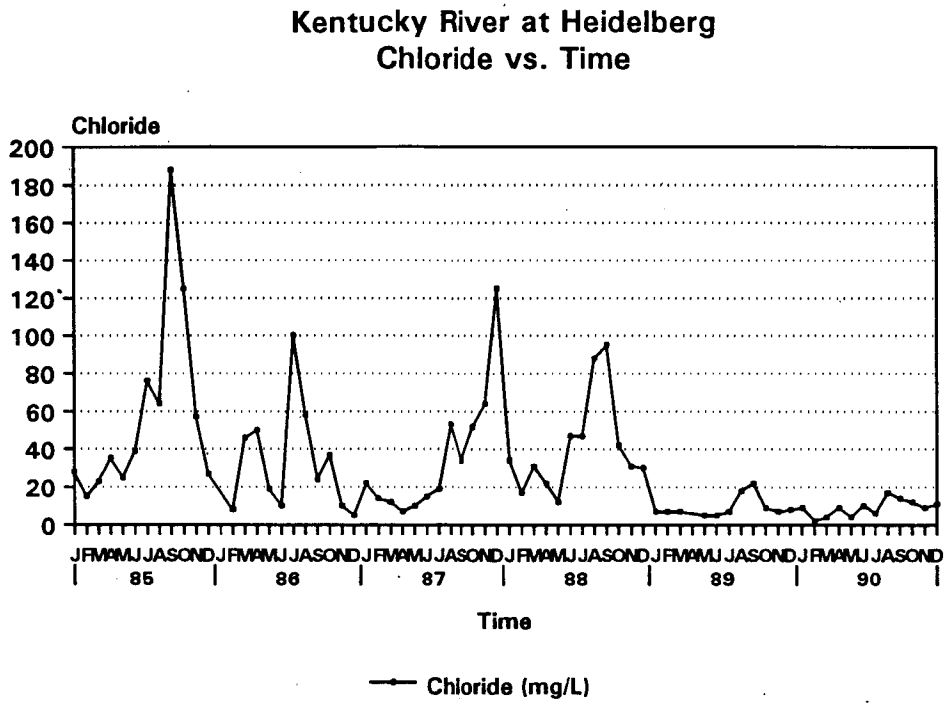
The Licking River near Salyersville has also shown a marked decrease in chloride concentrations (see Figure 1). Data from the DOW monitoring site have shown a decrease in the median chloride values beginning in 1989. The median was 227 mg/l in 1986, 140 mg/l in 1987, and 177 mg/l in 1988. In 1989 the median was 33 mg/l and in 1990 it was 27 mg/l. Maximum values had been above the domestic water supply

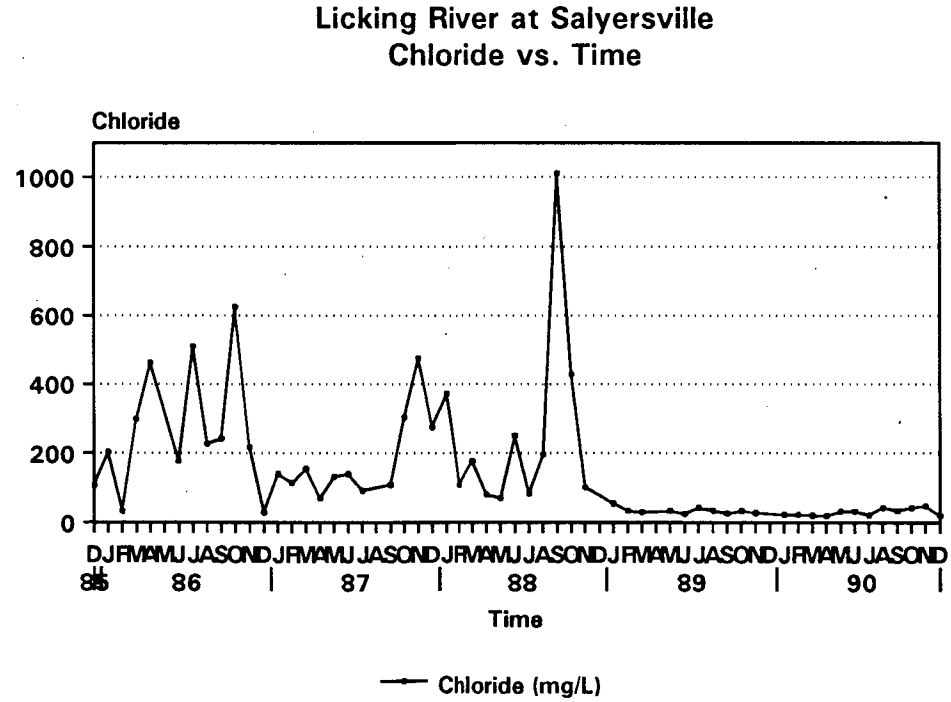
Table 9
Changes in Use Support
1990 to 1992

Waterbody	Full Support		Not Support	
	Aquatic Life	Swimming	Aquatic Life	Swimming
Big Sandy River near Louisa			X	X
Blaine Creek	X			
Tygarts Creek		X		
Licking River near Covington			X	X
Cat Creek			X	
Middle Fork Kentucky River		X		
Red River near Clay City			X	
Kentucky River near:				
Heidelberg		X		
Boonesboro				X
Frankfort		X		
Lockport				X
Eagle Creek				X
Elkhorn Creek				X
Cumberland River near:				
Cumberland Falls				
Burkesville		X		
Rolling Fork near New Haven		X		X
Floyds Fork			X	
Long Run	X			
Green River near:				
Munfordsville		X		
Morgantown		X		
Sebree	X			
Barren River near:				
Bowling Green	X			
Bacon Creek				X
Little River near Cadiz		X		
East Fork Clarks River		X		
Mayfield Creek near:				
Blandville		X		
Mayfield			X	
Bayou de Chien		X		

X - Denotes change in status from 1990

Figure 1


Kentucky River at Heidelberg
Chloride vs. Time
Chloride
200
180
160
140
120
100
80
60
40
20
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
85
86
87
88
89
90
Time
Chloride (mg/L)


Licking River at Salyersville
Chloride vs. Time
Chloride
1000
800
600
400
200
0
D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
85
86
87
88
89
90
Time
Chloride (mg/L)

criterion of 250 mg/l for several years and interfered with this use for the city of Salyersville. For instance, the maximum concentrations were 625 mg/l, 474 mg/l, and 1010 mg/l in 1986, 1987, and 1988 respectively. The maximum concentrations were 54 mg/l in 1989 and 47 mg/l in 1990.

The decrease in chloride concentrations in the Kentucky River and Licking River in the areas discussed above may be attributed to enforcement of the chloride limits on permits, decreases in oil production, and flow variations in the receiving streams.

Public Health/Aquatic Life Impacts: Toxics

Although the biological monitoring program focuses on the protection of aquatic life from toxics and conventional pollutants, an underlying theme of aquatic life protection is subsequent public health protection. The DOW has played an increasing role in public health protection through assessing the need for fish consumption advisories based on the concentrations of contaminants in fish tissue samples. Additionally, the Division coordinated a study to determine the extent of chlordane and PCB contamination in paddlefish fillets and eggs collected from the Ohio River. Data provided by the University of Louisville, concern regarding the commercial marketing of paddlefish fillets, and the use of paddlefish roe as domestic caviar prompted this investigation.

Fish Consumption Advisories

Four individual fish consumption advisories are currently in effect within the Commonwealth of Kentucky. All of these were discussed in the 1990 305(b) report and are still in place. They are briefly summarized in Table 10, and are discussed in detail below.

All of the advisories are based on contaminant residues exceeding the respective Federal Food and Drug Administration (FDA) action levels in edible portions (fillets). For each advisory, PCBs are a contaminant of concern. Chlordane is also of concern in the Ohio River advisory. All advisories were jointly agreed upon and issued by the Kentucky Natural Resources and Environmental Protection Cabinet (KNREPC), the Kentucky Department of Fish and Wildlife Resources (KDFWR), and the Cabinet for Human Resources (CHR). Operational protocols established in 1990 outline the roles of each agency in issuing fish consumption advisories. Additionally, ORSANCO and other Ohio River states were involved in issuing the advisory on the Ohio River.

Town Branch/Mud River. Fish samples representing nine species were collected from four locations on Town Branch during March 1990. All fish were analyzed as wholebody samples and indicated that PCBs are still of concern within this system.

Table 10
Fish Consumption Advisory Summary

Stream	Pollutants	Source	Miles Covered	Date Established	Comments
Town Branch/Mud River (Logan, Butler and Muhlenberg counties)	PCBs	Dye-casting plant	71.5	October 1985	Cleanup in progress; monitoring continues. All species covered.
West Fork Drakes Creek (Simpson and Warren counties)	PCBs	Adhesive plant	46.9	April 1985	Monitoring continues; levels in fish appear to be declining. All species covered.
Little Bayou Creek (McCracken County)	PCBs	Gaseous diffusion plant	6.5	April 1989	On-site clean-up in progress; monitoring continues; contamination appears limited to Little Bayou Creek. All species covered.
Ohio River	PCBs Chlordane	Urban runoff; no known point source discharge	663.9	June 1989	(Channel catfish, carp, White bass, Paddlefish). Monitoring continues, advisory re-issued 1992.

Samples of five fish species (carp, channel catfish, bluegill, largemouth bass, spotted bass) were collected from the lower portion of Mud River during September 1990. Analyses conducted included eleven metals, nine PCB Aroclors, nine chlordane isomers, and 28 other parameters. Results for chlordane, PCBs, and percent lipids are summarized in Table 11. Chlordane was not detected in any of the samples and PCBs were well below the FDA action level. Additional sampling is scheduled for Town Branch and the middle portion of Mud River during 1992.

Clean-up activities have been conducted on-site and at several off-site locations. Groundwater monitoring has continued and a dye tracing study was recently completed. A groundwater collection system design has been selected and plans for the placement are being finalized. Also, deep aquifer extraction wells have been put into place. Sampling and analysis of Town Branch floodplain soils has been conducted. This information will be used to help determine necessary remediation activities for the Town Branch floodplain area. Sediment clean-up in Town Branch is scheduled to begin in 1992.

West Fork Drakes Creek. Fish-tissue samples were collected in August 1990. Six species (stoneroller, silver shiner, white sucker, bluegill, longear sunfish, spotted bass) were collected and analyzed for 58 parameters. Chlordane, and percent lipid results are summarized in Table 11. Chlordane concentrations were well below the FDA action level. Although PCB levels did not exceed the FDA action level for edible portions, the wholebody samples indicated that PCBs are still of concern in this system, and the stream is scheduled to be sampled by DOW during 1992. The University of Kentucky collected fish samples during late 1991 and early 1992. Upon completion of DOW sampling and analysis, and after reviewing the UK results, this advisory will be re-evaluated.

Little Bayou Creek. This stream was placed under a fish consumption advisory in 1989 after the DOW received and reviewed fish-tissue data from the Paducah Gaseous Diffusion Plant (PGDP). During 1987-1989, approximately 53 percent of the fish samples exceeded the FDA action level for PCBs (2.0 ppm). While the advisory covers all species, green and longear sunfish were the predominate species that were collected and analyzed. The plant is conducting on-site clean-up activities, monitoring effluent quality, and performing groundwater studies. Chemical, ecological, and fish-tissue evaluations were conducted in Big and Little Bayou Creeks by the University of Kentucky during 1987-1991.

About 240 fish have been collected from Big Bayou Creek and analyzed for PCBs. Of these, only 4 percent have exceeded the FDA action level for PCBs. Fish samples collected from nearby ponds on the West Kentucky Wildlife Management Area and from Metropolis Lake during 1989 generally did not indicate PCB contamination. Additional monitoring at the PGDP is scheduled during 1992.

Table 11
1990 Fish Tissue Data for Two Fish Consumption Advisory Areas*

Stream/ Species	Chlordane	PCBs	Aroclor Detected	Percent Lipids
Mud River				
Carp (3)-F**	-	0.18	1254	2.6
Channel catfish (3)-F	-	0.17	1260	2.6
Bluegill (8)-WB	-	-	-	1.3
Largemouth bass (2)-F	-	-	-	0.6
Spotted bass (2)-F	-	0.63	1248, 1254	1.0
West Fork Drakes Creek				
Stoneroller (12)-WB	0.074	1.16	1248	10.0
Silver shiner (12)-WB	0.116	2.19	1248, 1254	14.6
White sucker (1)-WB	-	0.65	1248	4.7
Bluegill (3)-WB	0.008	0.45	1248, 1254	2.2
Longear sunfish (7)-WB	0.042	0.72	1248, 1254	2.5
Spotted bass (1)-F	0.079	1.27	1248, 1254	3.1
Spotted bass (2)-WB	0.127	2.15	1248, 1254	3.8

*Chlordane and PCB results are ppm
**F denotes fillet sample
WB denotes wholebody sample
Number in pararenthesis denotes number of fish in composite sample
- Not detected

Ohio River. Fish tissue samples were collected and analyzed through the cooperative efforts of KNREPC, KDFWR, CHR, FDA and ORSANCO. Fish samples were obtained during lockchamber studies and related electrofishing activities and by special sampling efforts aimed specifically at paddlefish.

The current advisory, based on the 1990 and 1991 fish-tissue results (Appendix A(1)) still covers that portion of the Ohio River bordering Kentucky. The four species covered in the 1992 advisory are: channel catfish, carp, white bass, and paddlefish. Paddlefish eggs are also included in the 1992 advisory because of their use in domestic caviar and the presence of chlordane levels exceeding the 0.3 ppm FDA action level (Appendix A(1)).

Additional sampling activities planned for 1992 include lockchamber studies and related electrofishing activities. Upon completion of sample collection and analysis, the fish consumption will be re-evaluated.

National Bioaccumulation Study Follow-up

Eleven locations in Kentucky have been previously sampled as part of the National Dioxin Study and the National Bioaccumulation Study conducted by the EPA. The Division of Water participated in these studies by providing information on sampling locations and by collecting fish samples for analysis by EPA/Region IV. Chlordane, dioxin, and PCB results were included in the 1990 305(b) report.

Only one sample collected by Kentucky during these studies approached the FDA Level of Concern for dioxin (25 ppt). A 1989 composite fillet sample taken from two striped bass collected in the Big Sandy River near Catlettsburg, Kentucky, was analyzed by EPA/Region IV and found to contain 22.8 parts per trillion (ppt) dioxin. As a result of joint efforts by the U.S. Army Corps of Engineers-Huntington District, the Division of Water, and the West Virginia Division of Natural Resources, follow-up fish and sediment sampling were conducted during 1990. Fish were collected at five locations on the Big Sandy River during July and August 1990.

Twelve fillet samples representing seven species were submitted for analysis. Dioxin, furan, and lipid results are summarized in Appendix A(2). No dioxin concentrations exceeded the 25 ppt Level of Concern established by FDA. The highest dioxin concentration observed was 17.0 ppt in a channel catfish composite sample (Appendix A(2)). Dioxin and furan were not detected in sediment samples collected by the Huntington District Corps of Engineers. Currently, no fish consumption advisory has been issued.

Public Health/Aquatic Life Impacts: Non-toxics

Non-toxics are conventional pollutants such as chlorine, un-ionized ammonia, oxygen demanding substances, and pathogenic organisms such as bacteria and viruses. These pollutants are a cause of concern because they are often responsible for fish kills, or like bacteria and viruses, can pose a threat to human health. Reports on fish kills, bacteriological evaluations of water quality, and beach closures are discussed below.

Fish Kill Incidents

Thirty-three fish-kill reports were received by KDFWR between January 1, 1990, and December 31, 1991. These involved slightly more than 56 stream miles and 26 surface acres on 35 different waterbodies. Seven major causes were identified, with organic enrichment by wastewater treatment plants (WWTPs) or animal wastes being predominant (45%). Nine fish kills were caused by unknown sources and ranged from 20 to over 22,000 fish killed. Over 134,000 fish valued at approximately $33,000 were estimated to have been killed. The two largest fish kills during this period accounted for almost half (45%) of the total fish killed. A chemical spill to Russell Fork during 1990 killed the greatest number of fish (38,576) during this period. Almost half (16) of the fish kills investigated occurred in July, August, and September. Table 12 summarizes the severity, causes, and locations of fish kills during 1990-91. Appendix A(3) shows a more detailed list of the fish kills that were investigated.

A 12-year synopsis (1980-91) of fish kill records is shown in Table 13. During this period, the number of major (greater than 1000 fish) fish kills occurring each year has remained fairly low (ten or less). For the current 305(b) reporting period (1990-91), the number of major fish kills recorded (12) and the number of waterbodies affected were lower than those for previous two 305(b) reporting periods. The number of stream miles affected and the number of fish killed (134,208) were also lower than in the previous four years.

Bacteriological Evaluations of Swimming Use

Fecal coliform bacteria are measured in water samples as indicators of other disease-causing bacteria. The most common illnesses experienced from swimming in fecally contaminated waters are gastroenteritis, ear infections, and skin infections (swimmers itch). During the 1990-1991 recreation seasons, bacteriological surveys were conducted in the areas listed below.

- Upper Salt River and tributaries to Taylorsville Lake
- North Fork Kentucky River
- Three-mile Creek/Lower Licking River
- Embayment/Dock Areas at Lake Cumberland

Table 12
Fish Kill Summary

		1990	1991	Total
Severity:	Light (< 100)	1	2	3
	Moderate (100-1,000)	8	7	15
	Major (> 1,000)	5	7	12
	Unknown	2	1	3
	Total	16	17	33
Cause:	Sewage (WWTP)	4	5	9
	Agricultural operation	3	3	6
	Mining or oil operation	0	2	2
	Oil or chemical spill	2	1	3
	Natural (low D.O., etc.)	1	2	3
	Herbicides	0	1	1
	Unknown	6	3	9
	Total	16	17	33
River Basin:	Big Sandy	4	3	7
	Licking	4	4	8
	Kentucky	3	3	6
	Salt	1	1	2
	Green	4	2	6
	Upper Cumberland	0	2	2
	Lower Cumberland	0	0	0
	Tennessee	0	0	0
	Ohio tributaries	0	2	2
	Total	16	17	33
Approximate number of stream miles		19.4	36.93	56.33
Approximate acres of lakes		1.1	25.0	26.1
Estimated number of fish killed		74,170	60,038	134,208

Table 13
Fish Kill Synopis, 1980-1991

Year	Number of Incidents	Number of Water-bodies	Stream Miles Affected	Surface Acres Affected	Number Fish Killed	Number Major Fish Kills*	Known Causes
1980	24	25	53.2	-	224,136	10	10
1981	26	30	74.3	-	81,266	7	10
1982	26	28	52.0	72.0	98,436	5	12
1983	36	41	51.3	7.0	76,187	8	19
1984	33	35	67.3	47.5	106,514	7	18
1985	29	27	86.9	4.5	59,499	5	9
1986	23	20	23.3	47.0	129,560	8	9
1987	30	32	58.3	200.0	229,583	10	14
1988	19	16	105.6	-	319,212	10	10
1989	23	23	47.8	9.0	222,330	9	11
1990	16	17	19.4	1.10	74,170	5	5
1991	17	18	36.9	25.0	60,038	7	7

*> 1000 fish killed

The upper Salt River, its tributaries, and tributaries to Taylorsville Lake were monitored for fecal coliform as part of a DOW study on point and nonpoint source impacts to Taylorsville Lake. The samples were collected twice in August 1990. The North Fork of the Kentucky River was monitored as a follow-up to its nonsupport of swimming use which was reported in the 1990 305(b) report. Sampling over weekly intervals in the 1990 recreation season resulted in a posting of a nonswimming advisory by the Division in 1990 and 1991. That advisory is still in effect and monitoring is continuing in-stream and at point sources in order to determine if the advisory can be cancelled. The Division has worked with municipalities in the area to improve wastewater treatment plant operations and reduce fecal coliform pollution.

Three-mile Creek discharges to the Licking River near Covington, Kentucky. The Division sampled this creek, Bank Lick Creek, the lower Licking River, and creeks near the town of Melbourne in 1991 and found they were polluted by fecal coliform bacteria. Advisories were sent to residents, creeks were posted, and notices were published in local newspapers about the risk of bodily contact in these waters. The Division plans to continue monitoring these areas in the 1992 recreation season to determine if the advisories need to be continued and to identify pollution sources.

Houseboat slip and dock areas on Lake Cumberland have been monitored for fecal coliform levels on a monthly basis, during the recreation season, since 1988. Areas around the Burnside, Jamestown, Alligator, and Grider Hill docks have shown no evidence of fecal coliform pollution. Five areas in the main lake outside of marina and dock influences are also monitored and have shown no evidence of fecal coliform pollution. The lake is considered to be safe for swimming.

Beach Closures

During the 1990 and 1991 recreation season beaches were closed at only one of 11 state parks. The beach on the Kentucky River at Fort Boonesboro State Park was closed on July 6, 1990. The Department of Parks is building a swimming pool at the park that will replace the beach as a swimming area. The Department of Parks monitored the following state park beaches:

Barren River Lake
Lake Barkley
Kenlake
J.J. Audubon (Scenic Lake)
Fort Boonesboro
(Kentucky River)
Rough River Lake
Green River Lake
Buckhorn Lake
Lake Malone
Greenbo Lake
Pennyrile Lake

Wetland Information

The loss of valuable wetland resources, and adverse impacts to remaining areas, are of special concern to Kentucky. Over half of the original wetland acreage has been destroyed. Nearly all of the areas that remain have been degraded by pollutants, such as pesticides, acid mine drainage, siltation, brine water, and/or domestic and industrial sewage. However, Kentucky still does not have an active wetland monitoring program. There continues to be a poor understanding of what once occurred, what is left, and current impacts and rates of loss.

According to the most recent (1979) USFWS classification system, the majority of Kentucky's wetlands fall in the Palustrine System. Areas lying shoreward of rivers and lakes, including floodplains, oxbows, ponds, marshes, and swamps, are members of the Palustrine System. The broad alluvial floodplains of the Ohio and Mississippi Rivers and their tributaries in western Kentucky comprise the vast

majority of Kentucky's wetlands. The class type within these floodplain areas is mostly bottomland hardwood forests with inclusion of scrub-shrub and emergent types of vegetation. Small ponds are common throughout the state and their area is difficult to assess. However, ponds have important value as ecological epicenters.

In 1985, the DOW provided funding to the Kentucky State Nature Preserves Commission to determine the status of Kentucky's wetlands. Recommendations for protection of remaining wetland areas were included in their 1986 report Wetland Protection Strategies for Kentucky. Among their findings was an estimate that, as of 1978, 637,000 acres remain of the original 1,566,000 acres of wetlands in Kentucky, see Table 14. Further, it was estimated that only 20 percent of Kentucky's wetland soils remain forested, which reflects a dramatic decline in bottomland hardwood wetlands. The Kentucky Department of Fish and Wildlife Resources estimates Kentucky's annual rate of wetland loss at 3,600 acres. This information provides only a rough estimate of Kentucky's wetland trends.

Table 14
Extent of Wetlands, By Type

Wetland Type	Historical Extent (acres)[1]	1990 305(b) Acreage[2]	Most Recent Acreage
Palustrine-All Types	1,566,000	637,000	637,000

Source of Information:
[1]Kentucky Soil and Water Conservation Commission. 1982. Kentucky Soil and Water Conservation Program. Part 1.
[2]Kentucky Nature Preserves Commission. 1986. Wetland Protection Strategies for Kentucky.

Water Quality Standards for Wetlands

Kentucky water quality standards include wetlands as waters of the state, but do not provide specific wetlands criteria. As waters of the state, wetlands are designated for the uses of warmwater aquatic habitat and contact recreation. Additionally, three of Kentucky's wetlands have been designated as outstanding resource waters.

In 1991, the DOW received a grant under Section 104(b)(3) of the Clean Water Act to address deficiencies in the water quality standards regarding wetlands protection. Under this grant selected wetlands were added to the reference reach monitoring program. Representative wetlands were selected within physiographic regions for monitoring to characterize chemical water quality, sediment quality, fish

tissue residue, habitat condition, and general biotic conditions. From this information, decisions will be made regarding: designation of appropriate stream use classifications, modifications to numerical chemical criteria, and development of narrative or numerical biocriteria. This information will not be available for use during Kentucky's next triennial review, scheduled for 1992.

401 Certification

Any applicant for a federal permit for an activity that could result in any discharge of a pollutant into a regulated state wetland is required to obtain a Section 401 water quality certification from DOW. The state is to certify that the materials to be discharged into a wetland will comply with the applicable effluent limitations, water quality standards, and any other applicable conditions of state law. Section 401 requirements pertain to any activity that requires a federal permit and that may result in a discharge to state water. Discharges may include but are not limited to dredged spoil, solid waste, garbage, rock, and soil. The state certification process is typically triggered through a Section 404 permit application and the associated Corps of Engineers Public Notice.

The Corps of Engineers public notice includes a request for 401 certification. Upon receipt, DOW initiates review for potential adverse impacts to designated uses of wetlands. Review focuses on possible violations of state regulations designed to protect water quality and aquatic life. Additional information, such as wetland mitigation plans, may be requested during the review process. The certification decision is submitted to the applicant and the Corps of Engineers.

Sufficient information to process a 401 certification is normally provided through the federal permit application and public notice process. If additional information is required, the applicant is so notified by the DOW. The Corps has the authority to issue general permits for certain categories of activities, which provide blanket authorization on a nationwide, state, or regional level, provided there are minimal adverse impacts on the environment. Such proposed activities do not require individual permits as long as the project complies with the conditions in the general permit. However, the proposed activity requires a Section 401 water quality certification in Kentucky if the action involves discharges into one acre or more of wetland.

Consistent with Section 401 and Kentucky water quality standards, wetlands impacts should be avoided or minimized wherever possible. When unavoidable impacts occur, appropriate compensation is required to replace the lost functions. Unavoidable wetland losses, incurred as a result of the permitting process or as a result of an illegal fill and subject to enforcement, require mitigation (restoration, creation, and/or enhancement) to compensate for wetlands unavoidably lost.

Attainment of functional equivalency should be the goal of all mitigation activities. The choice of restoration, creation, or enhancement mitigation for any project depends upon the site specific characteristics of available locations. The choice should be based upon analysis of factors that limit the ecological functioning of the watershed, ecosystem or region. Ideally, mitigation should be in the form of restoration of "prior converted" wetlands as defined by the Corps of Engineers. Mitigation should be initiated either before or at the same time that the proposed project work is being undertaken. The mitigation plan must be made part of the project application. Where an activity does not result in a permanent loss, on-site restoration in addition to compensatory mitigation should occur.

The principal deficiencies in the federal Section 404 permitting program and the state water quality certification program are the lack of effective compliance assurance and enforcement elements. The Corps of Engineers and DOW need to significantly increase surveillance and enforcement activities in order to ensure permitted and/or unpermitted activities are not degrading or eliminating wetland resources.

CHAPTER 2

WATER QUALITY ASSESSMENT OF LAKES

WATER QUALITY ASSESSMENT OF LAKES

Section 314 of the Clean Water Act of 1987 requires that states submit a lake water quality assessment as part of their biennial 305(b) report. Six areas are to be included in the assessment. These are:

(1) An identification and classification according to eutrophic condition, of all publicly-owned lakes in a state.

(2) A general description of the state's procedures, processes, and methods (including land use requirements) for controlling lake pollution.

(3) A general discussion of the state's plans to restore the quality of degraded lakes.

(4) Methods and procedures to mitigate the harmful effects of high acidity and remove or control toxics mobilized by high acidity.

(5) A list and description of publicly-owned lakes for which uses are known to be impaired, including those lakes that do not meet water quality standards or that require implementation of control programs to maintain compliance with applicable standards, and those lakes in which water quality has deteriorated as a result of high acidity that may reasonably be due to acid deposition.

(6) An assessment of the status and trends of water quality in lakes including the nature and extent of pollution loading from point and nonpoint sources and the extent of impairment from these sources, particularly with regard to toxic pollution.

The U.S. Environmental Protection Agency (EPA) has developed a guidance document Guidelines for the Preparation of the 1992 State Water Quality Assessments (305(b) Reports (August 1991), which includes a section on lake assessment reports. Kentucky's report generally complies with the guidelines suggested by the EPA.

Lake Identification

Appendix B lists publicly-owned lakes for which data were available to assess trophic status. Much of this information came from recent lake surveys (1989-1991) conducted by the Division of Water and Murray State University as part of a cooperative agreement funded under Section 314 of the Clean Water Act. The surveys were conducted on lakes which had originally been sampled by the Division of Water in 1981-1983 and on 11 lakes which had not previously been surveyed. Not all of the significant publicly-owned lakes in Kentucky are included in the table because data have not been collected from all such lakes. For purposes of this report, publicly-owned lakes are those lakes that are owned or managed by a public entity such as a city, county, state, or federal agency where the public has free access for use. A nominal fee

for boat launching charged by concessionaires may occur on some of these lakes. Lakes that are publicly-owned, but restrict public access because they are used solely as a source of domestic water supply, are not included. These lakes do not qualify for federal restoration funds under the Clean Lakes Program and were not monitored in the lake classification survey. In addition, Lewisburg Lake has been removed from the list of significant lakes because public access has been restricted. EPA guidance suggests that all significant lakes be included in state surveys. The term "significant" is to be defined by the state so that all lakes that have substantial public interest and use would be included. For this purpose, Kentucky considers all of the publicly-owned lakes it has surveyed and listed in Appendix B and also those which have not yet been surveyed, but qualify as publicly-owned lakes, as significant. All of these lakes have substantial local or regional public interest and use.

Trophic Status

Lake trophic state was assessed by using the Carlson Trophic State Index (TSI) for chlorophyll α. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy and also provides for a distinction (according to TSI value) between oligotrophic, mesotrophic and eutrophic lakes. The growing season average TSI (chlorophyll α) value was used to rank each lake. Growing season was defined as the April through October period. A distinction was made for those lakes which exhibited trophic gradients. If lakes exhibited trophic gradients or embayment differences, those areas were often analyzed separately.

While there are several other methods of evaluating lake trophic state, the accuracy and precision of the chlorophyll α analytical procedure (determined from Division of Water quality control data) and proven ability of the chlorophyll α TSI to detect changes, made it the index of choice for classifying lakes in Kentucky's program.

Chlorophyll α concentration data from the ambient monitoring program, and the most current chlorophyll α data collected during the spring through fall seasons (a minimum of 3 samples) by the U.S. Army Corps of Engineers (COE) on several reservoirs which they manage, were used to update the trophic classifications for this report. Other data were obtained from a report on a study of Lake Barkley conducted by Dr. Joe M. King of Murray State University. Data averaged from water column depths of up to 20 feet were used in calculating TSI values. Table 15 contains the trophic state rankings of lakes of 5,000 acres or more in size and Table 16 lists and ranks the trophic state of lakes less than 5,000 acres in size. Lakes that have updated classifications are in bold face type. A "+" or "-" symbol is used to indicate a trend of increasing or decreasing trophy. Trends were defined as a change of ten units from a previous TSI score. This represents a doubling or halving of Secchi disk depth and was chosen because it is a noticeable indication of change.

A summary of Tables 15 and 16 indicates that of the 102 classified lakes, 61 (60%) were eutrophic (3 being hypereutrophic), 30 (29%) were mesotrophic, and 11 (11%) were oligotrophic. This is based on the status of the major areas of lakes and does not account for the trophic gradient that exists in some reservoirs nor the trophic status of the embayments of others. The dynamic nature of these reservoirs makes it more difficult to assign them a single trophic state because their water residence times, the nature of major inflows, and their morphology can result in different trophic states in separate areas. The tables indicate that trophic gradients exist in Barren River and Laurel River lakes and that certain embayments of Lake Cumberland are eutrophic, while the main lake area is oligotrophic.

The 102 assessed lakes have a total area of 214,962 acres. Only those portions of lakes Barkley, Kentucky, and Dale Hollow lying within Kentucky were included in the total. Tennessee reports on those portions within its borders. Of the total, 51 percent (109,005 acres) were eutrophic while 29 percent (63,513 acres) were oligotrophic and 20 percent (43,444 acres) were mesotrophic. The decrease in eutrophic acres from the 1990 305(b) report is largely because Green River and Nolin River lakes were reclassified as mesotrophic based on more current lake data.

Lake Pollution Control Procedures

Kentucky utilizes several approaches to control pollution in its publicly owned lakes. The approach chosen is dependent upon the pollutant source and the characteristics of each lake. Point sources of potential pollution are more controllable than nonpoint sources. The following procedures are routinely used to control point sources of pollution.

Permitting Program

A lake discharge guidance procedure is in effect and is applied to any new construction permit for a facility that proposes to discharge into a lake, or for any application for a lake discharge permit under the Kentucky Pollutant Discharge Elimination System (KPDES). An applicant is required to evaluate all other feasible means of routing the discharge or to explore alternate treatment methods that would result in no discharge to a lake. As a last resort, a lake discharge may be permitted. Permits for domestic wastes require secondary treatment and a discharge into the hypolimnion in the main body of the lake. More stringent treatment may be required depending upon lake characteristics. Surface discharges are not allowed. A permit may also be denied to a prospective discharger if the discharge point is within five miles of a domestic water supply intake.

Table 15
Trophic State Rankings for Lakes
5,000 Acres or Greater in Area
(by Carlson TSI (Chl α) Values)

Lake	TSI (Chl α)*	Acres
	Eutrophic	
Barkley	61	45,600
Kentucky	**54**	**48,100**
	Mesotrophic	
Barren River	50	7,205
Beaver Creek Arm	57 (Eutrophic)	1,565
Skaggs Creek Arm	50	1,230
Green River	**48**	**8,210**
Rough River	48	5,100
Cave Run	45	8,270
Nolin	**43**	**5,790**
	Oligotrophic	
Cumberland	38	49,364
Lily Creek Embayment	**61 (Eutrophic)**	**144**
Beaver Creek Embayment	**57 (Eutrophic)**	**742**
Laurel River	34	4,990
Midlake-Laurel River Arm	47 (Mesotrophic)	754
Headwaters-Laurel River Arm	58 (Eutrophic)	316
Dale Hollow	33	4,300

*Scale: 0-40 Oligotrophic (nutrient poor, low algal biomass)
41-50 Mesotrophic (slightly nutrient rich, moderate amount of algal biomass)
51-69 Eutrophic (nutrient rich, high algal biomass)
70-100 Hypereutrophic (very high nutrient concentrations and algal biomass)
Bold Type = Updated Classifications,

Table 16
Trophic State Rankings for Lakes
Less Than 5,000 Acres in Area
(by Carlson TSI (Chl α) Values)

Lake	TSI (Chl α)*	Acres
	Hypereutrophic	
Beaver Dam	**86**	**50**
Mitchell	**85**	**58**
Happy Hollow	**75**	**20**
	Eutrophic	
Swan	69	193
Arrowhead	68	37
Fish	68	27
Spurlington	68+	36
Campbellsville City	67+	63
Jericho	**67+**	**137**
Marion County	67	21
McNeely	**67**	**51**
Reformatory	**67**	**54**
Taylorsville	**67**	**3,050**
Guist Creek	65	317
Wilgreen	**65**	**169**
Shelby (Shelby County)	**64+**	**17**
Buck	64	19
Metcalfe County	**64+**	**22**
Willisburg	64	126
Briggs	**63**	**18**
Kingfisher	**63**	**30**
Metropolis	63	36
Flat	62	38
Greenbriar**	**62**	**66**
Carpenter	**61**	**64**
Doe Run	61+	51
Sympson	**61+**	**184**
Burnt Pond	60	10
Long Pond	60	56
Moffit	**60**	**49**

Table 16 (Continued)

Lake	TSI (Chl α)*	Acres
Shelby (Ballard County)	**60**	**24**
Turner	60	61
Carnico	**59**	**114**
Scenic	**59**	**18**
A.J. Jolly	58	204
Energy	58	370
Corinth	57	96
Freeman	**57**	**160**
Sand Lick	57	74
Beaver	56	158
Bullock Pen	56	134
Elmer Davis	56	149
Kincaid	**56**	**183**
Malone	**56**	**826**
Mauzy	**56**	**84**
Spa	**56**	**240**
Washburn	**56**	**26**
Boltz	55	92
General Butler	55	29
George	**55**	**53**
Fishpond	**54**	**32**
Herrington	54	2,940
Salem	**54**	**99**
Shanty Hollow**	**54**	**135**
Carr Fork	53	710
Pennyrile	**53**	**47**
Williamstown**	**53**	**300**
Caneyville	**52**	**75**
Bert Combs	**51**	**36**
	Mesotrophic	
Chenoa	**50**	**37**
Corbin	**50**	**139**
Dewey	**50+**	**1,100**
Liberty	50	79
Long Run	50	27

Table 16 (Continued)

Lake	TSI (Chl α)*	Acres
Morris	**50**	**170**
Beshear	**49**	**760**
Hematite	49	90
Honker	49-	190
Laurel Creek	**49**	**42**
Linville	**49**	**273**
Pan Bowl	**49**	**98**
PeeWee	49	360
Greenbo	48	181
Luzerne	**48**	**55**
Mill Creek (Monroe County)	**48**	**109**
Smokey Valley	47	36
Tyner	**46**	**87**
Wood Creek	46	672
Blythe	**45**	**89**
Campton	**45**	**26**
Mill Creek (Powell County)	**43**	**41**
Paintsville	**43**	**1,139**
Providence City	**42**	**35**
Grapevine	**41-**	**50**
	Oligotrophic	
Grayson	39	1,512
Buckhorn	**38**	**1,230**
Loch Mary	**38**	**135**
Fishtrap	37	1,143
Martins Fork	37	334
Stanford	36	43
Cannon Creek**	**33**	**243**
Cranks Creek	**32**	**219**

*Scale: 0-40 Oligotrophic 51-69 Eutrophic
41-50 Mesotrophic 70-100 Hypereutrophic
Bold Type = Updated Classifications, ** = 2 samples only,
+/- = upward (more eutrophic) or downward (less eutrophic) trend

Water Quality Standards Regulations

Kentucky has not adopted specific criteria to protect lake uses. Warmwater aquatic habitat, domestic water supply (if the lake is used for this purpose), and primary and secondary contact recreation criteria are generally applicable to lakes. In specific cases, a provision in the water quality standards regulation can be utilized to designate a waterbody as nutrient limited if eutrophication is a problem. Point source dischargers to the lake and its tributaries can then have nutrient limits included in their permits.

Lakes that support trout are further protected by another provision that requires dissolved oxygen in waters below the epilimnion to be kept consistent with natural water quality.

Kentucky is not planning to adopt statewide criteria specifically for lakes. A site-specific approach to lake pollution control is more realistic and feasible.

Specific Lake Legislation and Local Initiatives

The Kentucky General Assembly has the prerogative to pass legislation to protect lakes. This action has been taken for Taylorsville Lake. House Joint Resolution No. 4 prohibits issuing any discharge permits that allow effluents to be directly discharged into the lake. It also prohibits issuing any permits that allow inadequately treated effluents to be discharged into contributing tributaries that drain the immediate watershed of the lake. In addition, wastewater permit applications in the basin above the lake must be evaluated to ensure that discharges will not adversely affect the lake or its uses. Other provisions provide for stringent on-site wastewater treatment requirements, promotion of nonpoint source controls, and proper management of sanitary landfills in the watershed.

Lake protection associations are not formally organized in Kentucky. This is one mechanism that has proven to be successful in preventing lake pollution in other states. Local ordinances can be passed that restrict land use activities and on-site treatment systems and lead to pollution abatement. Local grass roots opposition to activities which may degrade lakes can lead to state agency action. An example is the petition process in the state's surface mining regulations which can lead to lands being declared unsuitable for mining. Such a petition has been successfully made to protect the water quality of Cannon Creek Lake in Bell County. The lake is used as a water supply for the City of Pineville and is also used for fishing and recreation.

Lake Monitoring

Monitoring water quality in lakes is a part of Kentucky's ambient monitoring program and is described in Chapter 4. The objectives of the monitoring program are flexible so that lakes can be monitored for several purposes. These include:

- o detection of trends in trophic state
- o impacts of permit decisions
- o ambient water quality characterization
- o nonpoint source impacts
- o long-term acid precipitation impacts
- o pollution incidences such as fish kills and nuisance algal blooms
- o new initiatives such as fish tissue analysis for toxics and fecal coliform surveys in swimming areas.

Lake Restoration Plan

Kentucky has not developed a formal state Clean Lakes Program. Several states have adopted a program modeled after the federal Clean Lakes Program and have had state funds appropriated to aid in lake restoration projects. The impetus for developing these programs has been the historical importance of lakes as recreational and aesthetic resources in these states. Pollution or the potential for pollution has prompted support for state development of these programs. Pollution of lakes in Kentucky has not reached a point where there is a recognized need to develop a state program of this nature.

The Division of Water does participate in the federal Clean Lakes Program. The Natural Resources and Environmental Protection Cabinet is the state agency designated by the Governor to receive federal assistance under this program. Kentucky has received three assistance awards. Two helped to fund projects which classified lakes in the state according to trophic state and assessed their need for restoration. The other award helped to fund a diagnostic/feasibility study of McNeely Lake in Jefferson County.

The Division of Water cooperated with local and federal agencies in all of these projects and prepared a grant for implementation of the restoration plan for McNeely Lake. The grant was not awarded because it was technically not eligible for assistance under federal guidelines. However, Jefferson County passed a bond issue to finance the implementation of the plan. It was completed in December of 1988. The Division is monitoring the lake as part of its ambient program to document water quality improvements.

The Division of Water is ready to cooperate with local agencies and other interested groups to participate in the federal Clean Lakes Program. The preparation of the lake assessment chapter in the 305(b) report is a requirement for future participation in that program.

Toxic Substance Control/Acid Mitigation Activities

Kentucky does not have publicly-owned lakes that have high acidity caused by acid precipitation; consequently, this requirement does not apply and will not be addressed.

Identification of Impaired and Threatened Lakes

Table 17 summarizes information on overall use support for Kentucky lakes. This information was gathered from published annual reports produced by the COE on reservoirs which they manage, from research reports by other investigators, and from Division of Water data bases. The total acres assessed are equal to the acres monitored. The analysis is based on chemical data relating to iron, manganese, and dissolved oxygen problems, biological data relating to algal biomass (blooms), algae causing taste and odor problems, macrophyte infestations, and fish kill reports. Criteria were also developed based on other indicators of lake use support (see Table 18). One of the criteria for support of aquatic life indicates that a use was not being fully supported if the average dissolved oxygen concentration within the epilimnion was less than 5 mg/l. This criterion and pH are related to aquatic life standards.

Table 17
Summary of Lake Use Support

Degree of Use Support	Assessment Basis (Monitored)	Total Assessed
Acres Fully Supporting	100,454	100,454
Acres Threatened	94,839	94,839
Acres Partially Supporting	12,931	12,931
Acres Not Supporting	6,738	6,738

Acres Assessed - 214,962
Total Kentucky Lake Acreage - 228,385

The total acres reported in Table 17 is based on the Division of Water's Dam Inventory Files and the acres inventoried in the lake classification program. The assessed acres represent over 90 percent of the publicly-owned lake acreage in the state. The U.S. EPA published a draft document in December, 1991 entitled Total State Waters: Estimating River Miles and Lake Acreages for the 1992 Water Quality Assessments (305(b) Reports), which lists total lake acreage in Kentucky as 182,169 acres. The acreages are computer derived from USGS 1:24,000 scale maps for lakes shown on the USGS 1:100,000 scale map series. This total is less than the estimate in this report. The Division of Water derived its estimate of lake acreages from engineering drawings in its Dam Inventory Files, from reported acres (at certain elevations) in U.S. Army Corps of Engineers project reports of its major reservoirs in the state, and by planimetering USGS 1:24,000 scale map series for lakes with no reported acres. These are

Table 18
Criteria for Lake Use Support Classification

Category	Warmwater Aquatic Habitat	Secondary Contact Water Recreation	Domestic Water Supply
Not Supporting:	At least two of the following:	At least one of the following:	At least one of the following:
	1. Fish kills caused by poor water quality	1. Widespread excess macrophyte/macroscopic algal growth	1. Chronic taste and odor complaints caused by algae
	2. Severe hypolimnetic oxygen depletion	2. Chronic nuisance algal blooms	2. Chronic treatment problems caused by poor water quality
	3. Dissolved oxygen average less than 5 mg/l in the epilimnion		
Partially Supporting: (At least one of the listed criteria).	1. Dissolved oxygen average less than 5 mg/l in the epilimnion	1. Localized or seasonally excessive macrophyte/macroscopic algal growth	1. Occasional taste and odor complaints caused by algae
	2. Severe hypolimnetic oxygen depletion	2. Occasional nuisance algal blooms	2. Occasional treatment problems caused by poor water quality
	3. Other specific cause (i.e. low pH)	3. High suspended sediment concentrations during the recreation season	
		4. Other specific cause (i.e. low pH).	
Fully Supporting:	1. None of the above	1. None of the above	1. None of the above

considered to be more accurate estimates than those reported by U.S. EPA. Many lakes have been classified by use in Kentucky and are listed in Kentucky's water quality standards. Waters not specifically listed by use in water quality regulations are generally classified for the uses of warmwater aquatic habitat, primary and secondary contact recreation, and domestic water supply at points of withdrawal. Lake use support is based on these uses. Primary contact recreation was not assessed because the primary indicator of use support (fecal coliform bacteria) was not measured as part of agency monitoring programs.

Detailed information on formerly assessed lakes can be found in the report on the lake classification program entitled Trophic State and Restoration Assessments of Kentucky Lakes, which was published in 1984 by the Division of Water. Detailed information on newly assessed lakes will be included in the final report of the lake assessment project. Appendix B lists summary information on all of the lakes assessed.

Table 19 and Table 20 list lakes according to whether their uses are not supported or are partially supported. The tables indicate which criteria from Table 18 were used to determine nonsupport or partial support and the probable causes and sources for the support not being achieved. Table 21 lists those lakes which fully support their uses.

Ninety-one percent of the total acres assessed supported uses while nine percent did not fully support uses. Nine of the ten lakes over 5,000 acres in size fully supported uses. Rough River Lake is the exception. The domestic water supply use of this lake is partially supported because of occasional treatment problems caused by natural sources of manganese. More than half of the small lakes fully supported their designated uses (55 of 92) or 60 percent. Twenty-eight of these lakes (30%) partially supported a particular use. Nine lakes did not support one or more uses. Briggs, Herrington and Mauzy lakes are new additions to this category. Reformatory Lake was removed from the list and placed in the partial support category because of improved water quality. In total, of the 102 lakes assessed, 64 fully supported their uses (63%), 29 lakes partially supported uses (28%) and nine lakes did not support one or more uses (9%).

Hazards to human health through consumption of fish or swimming in waters contaminated by bacteria were not considered as problems in any of the listed lakes. Table 22 summarizes use support information for lakes based on acres and number of lakes.

EPA guidance asks for a list of threatened lakes. These are defined as lakes that fully support uses now, but may not in the future because of anticipated sources or adverse trends of pollution. Table 17 indicates the total acres classified as threatened. Table 23 lists the lakes and indicates what uses are threatened and the causes and sources of the threats.

Table 19
Lakes Not Supporting Uses

Lake	Use Not Supported*	Criteria**	Cause	Source
Briggs	WAH	2,3	Nutrients	Lake fertilization
Corbin	DWS	1	Nutrients	Municipal point sources and Agricultural nonpoint sources
Herrington	WAH	1,3	Nutrients	Municipal point sources and Agricultural nonpoint sources, septic tanks
Jericho	WAH	2,3	Nutrients	Agricultural nonpoint sources
Loch Mary	DWS	2	Metals (Mn) and other inorganics (noncarbonate hardness)	Surface mining (abandoned lands)
Mauzy	WAH	2,3	Nutrients	Lake fertilization
McNeely	WAH	2,3	Nutrients	In-place contaminants (sediments)
Sympson	DWS	1	Nutrients	Agricultural nonpoint sources
Taylorsville	WAH	2,3	Nutrients	Municipal point sources and Agricultural nonpoint sources

*WAH - Warmwater Aquatic Habitat, SCR - Secondary Contact Recreation, DWS - Domestic Water Supply
**Refer to Table 18

Table 20
Lakes Partially Supporting Uses

Lake	Use*	Criteria**	Cause	Source
Beshear	WAH	1	Nutrients	Natural
Buckhorn	SCR	3	Suspended solids	Surface mining
Campbellsville	WAH	1	Nutrients	Agricultural nonpoint sources
Caneyville	DWS	1	Nutrients	Natural
	SCR	1	Nutrients	Natural
Carpenter	SCR	1	Shallow lake basin	Natural
	WAH	1	Nutrients	In-place contaminants (sediments)
Carr Fork	SCR	3	Suspended solids	Surface mining
Cranks Creek	WAH	3	pH	Mining (abandoned lands)
	SCR	3	pH	Mining (abandoned lands)
Dewey	SCR	3	Suspended solids	Surface mining
Fishtrap	SCR	3	Suspended solids	Surface mining
George	WAH	1	Nutrients	Agricultural nonpoint sources
Guist Creek	DWS	1	Nutrients	Agricultural nonpoint sources
	WAH	1	Nutrients	
Honker	WAH	1	Nutrients	Natural
Kincaid	WAH	1	Nutrients	Unknown
Laurel Creek	DWS	1	Nutrients	Natural
Laurel River (Headwaters)	SCR	1	Nutrients	Municipal point sources and Agricultural nonpoint sources
Liberty	DWS	2	Metals (Fe and Mn)	Natural
Martins Fork	SCR	3	Suspended Solids	Surface mining
Marion County	SCR	2	Nutrients	Lake fertilization
Metcalfe County	SCR	1	Shallow lake basin	Natural
	WAH	2	Nutrients	Agricultural nonpoint sources

Table 20 (Continued)

Lake	Use*	Criteria**	Cause	Source
Morris	DWS	1	Nutrients	Agricultural nonpoint sources
Reformatory	WAH	2	Nutrients	Agricultural nonpoint sources
Rough River	DWS	2	Metals (Mn)	Natural
Salem	SCR	1	Shallow lake basin	Natural
Sand Lick Creek	WAH	1	Nutrients	Agricultural nonpoint sources
Scenic	WAH	1	Nutrients	In-place contaminants (sediments)
Shelby (Shelby Co.)	WAH	1	Nutrients	Agricultural nonpoint sources/In-place contaminants (sediments)
Spa	WAH	1	Nutrients	Agricultural nonpoint sources
Stanford	DWS	1	Nutrients	Natural
Wilgreen	WAH SCR	2 2	Nutrients Nutrients	Septic tanks Septic tanks
Washburn	WAH	2	Nutrients	Unknown

*WAH - Warmwater aquatic habitat, SCR - Secondary contact recreation, DWS - Domestic water supply
**Refer to Table 18

Table 21
Lakes Fully Supporting Uses

Size		
5000 Acres or Larger	**Less than 5000 Acres**	
Barkley	A.J. Jolly	Linville
Barren	Arrowhead	Long Pond
Cave Run	Beaver	Long Run
Cumberland	Beaver Dam	Luzerne
Dale Hollow	Bert Combs	Malone
Green	Blythe	Metropolis
Kentucky	Boltz	Mill Creek
Laurel River (except	Buck	(Monroe Co.)
for headwaters)	Bullock Pen	Mill Creek
Nolin	Burnt Pond	(Powell Co.)
	Campton	Mitchell
	Cannon Creek	Moffit
	Carnico	Paintsville
	Chenoa	Pan Bowl
	Corinth	Peewee
	Doe Run	Pennyrile
	Elmer Davis	Providence City
	Energy	Shanty Hollow
	Fish	Shelby (Ballard Co.)
	Fish Pond	Smokey Valley
	Flat	Spurlington
	Freeman	Swan Pond
	General Butler	Turner
	Grapevine	Tyner
	Grayson	Williamstown
	Greenbo	Willisburg
	Greenbriar	Wood Creek
	Happy Hollow	
	Hematite	
	Kingfisher	

Table 22
Use Support Summary for Lakes

(by Acres)

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting
Fish Consumption	214,962	0	0	0
Aquatic Life	156,974	49,239	2,469	6,280
Swimming	214,743	0	219	0
Secondary Contact	116,203	93,700	5,059	0
Drinking Water*	80,623*	0	5,826	458

Total Assessed Acres = 214,962
*Total Assessed Acres for Domestic Water Supply = 86,449

(by Number)

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting
Fish Consumption	102	0	0	0
Aquatic Life	78	2	16	6
Swimming	101	0	1	0
Secondary Contact	87	2	13	0
Drinking Water*	30	0	7	3

Total Assessed Lakes = 102
*Total Assessed for Domestic Water Supply = 40

Table 23
Threatened Lakes

Lake	Use* Threatened	Cause	Source
Kentucky	SCR	Macrophyte infestations	Natural or introduced exotic species
	WAH	Low dissolved oxygen	Unspecified nonpoint sources
Paintsville	WAH	Salinity/brine	Petroleum activities
Barkley	SCR	Suspended solids	Unspecified nonpoint sources

*SCR - Secondary Contact Recreation, WAH - Warmwater Aquatic Habitat

Table 24 indicates the causes responsible for nonsupport of lake uses. As noted in previous 305(b) reports, nutrients cause the greatest percentage of nonsupport and affect the largest number of lakes. Nutrients can stimulate a proliferation of algae, which may cause taste and odor problems in lakes used for domestic water supplies. Dissolved oxygen can also be lowered in surface waters by very productive algal populations that stimulate microbial respiration and may result in fish kills or a decrease in oxygen to levels that are not conducive to the support of healthy populations of fish. Metals are the second largest contributor to nonsupport of uses. The nonsupport is attributable to iron and manganese effects on lakes used for domestic water supplies. These metals are solubilized from lake sediments under anoxic conditions and cause water treatment problems. Suspended solids (the next largest contributor to nonsupport of uses) cause several reservoirs in eastern Kentucky to not fully support secondary contact recreational uses. Priority pollutants (toxics) did not cause any of the lake use impairments.

Table 25 indicates the sources responsible for nonsupport of lake uses. Agricultural sources are the single source responsible for the highest percentage of use nonsupport (29%). Nonpoint sources including agriculture account for the highest percentage of lake uses not being supported (57%). More detailed studies in watersheds of the lakes in the agriculture category are necessary before contributing sources of nonpoint pollution can be distinguished. Surface mining for coal (resource extraction) is the next greatest nonpoint source contributor to lake uses not being fully supported. Lake recreational uses are impaired because waters become turbid after receiving runoff water, laden with sediment from lands disturbed by surface mining activities. This reduces the incentive for secondary contact uses. Municipal point sources were responsible for 21 percent of the use nonsupport, as were natural causes.

Table 24
Causes of Use Nonsupport* In Lakes

Major Impact**	Number of Lakes Affected	Acres	% Contribution (by Acres)
Nutrients	29	9,520	48
Metals (Fe/Mn)	3	5,314	27
Suspended solids	5	4,517	23
pH	1	219	1
Other (Shallow lake basin)	3	185	1
Other inorganics (noncarbonate hardness)	1	135	<1

*Nonsupport is a collective term for lakes either not supporting or partially supporting uses
**No moderate or minor impacts were noted

Table 25
Sources of Use Nonsupport* in Lakes

Source	Major Impact (Acres)	Moderate/Minor Impact (Acres)
Point Sources		
Municipal	6,445	455
Nonpoint Sources		
Agriculture	8,727	
Resource Extraction	4,871	
Septic tanks	3,109	
Other		
Natural	6,474	
Lake fertilization	123	
In-place contaminants	334	
Unknown	209	

*Nonsupport is a collective term for lakes either not supporting or partially supporting uses

Water Quality Trend Assessment

Trophic Trends

One of the objectives of the ambient monitoring program is to assess eutrophication of Kentucky lakes. The monitoring strategy is to obtain at least two years of data during the growing season on each lake. After the data is assessed, a decision is made either to continue monitoring or to assess another lake.

A review of current lake data from the ambient monitoring program, data retrieved through STORET on COE managed lakes, data from the lake assessment program, and other reports resulted in an assessment of trophic trends at several lakes. As mentioned earlier, a change in the chlorophyll TSI value (averaged over the April - October growing season) of 10 units was used to indicate a trophic change. A discussion of trends from the above databases follows.

Lakes in the Assessment Program. TSI values were compared for those lakes assessed in 1981-1983 that had been resurveyed in 1989, 1990, and 1991. Comparisons of two data sets does not provide a strong trend analysis because the intervening years were not sampled. They do, however, indicate a change. The comparisons, as noted in Table 16 show that Spurlington, Campbellsville City, Jericho, Shelby (Shelby County), Metcalfe County, and Doe Run lakes were more eutrophic. Lake Jericho's change resulted in its warmwater aquatic habitat use not being supported. Wood Creek Lake changed from an oligotrophic to a mesotrophic state. No uses were impaired. Sympson Lake changed from a mesotrophic to a eutrophic state. Honker and Grapevine lakes changed from eutrophic to mesotrophic states.

Lakes in the Ambient Monitoring Program. The following is a discussion on individual lakes which have been monitored over several years by the Division of Water, the COE, and other researchers. Analyses are based on the combined databases. Trophic trends are indicated by a change in TSI values of 10 units or greater. The extent of these databases gives the trend assessments a high level of confidence.

Green River Lake. COE data from 1981 indicated that this lake might be changing from a mesotrophic to a eutrophic state. Subsequent sampling in 1985 and 1986 by the DOW showed the main body of the lake to be mesotrophic. The 1989 COE data indicated that the lake was eutrophic. The TSI value changed from 44 (mesotrophic) to 55 (eutrophic). Monitoring by the COE will indicate if this eutrophic trend continues. The Division monitored the lake in 1990 and 1991. The data showed that the lake was less eutrophic in 1990 and that it had returned to a mesotrophic state in 1991.

Nolin River Lake. The 1988 305(b) report indicated that this lake was changing from a mesotrophic to a eutrophic state. The period of record showed the lake to be mesotrophic from 1975 through 1983 (TSI average was 44). Data from 1982 through

1987 showed a eutrophic trend. The TSI value was 55 in 1987. The DOW monitored the lake in 1988 and verified that the lake was eutrophic (TSI was 52). COE data from 1990 showed the lake was mesotrophic (TSI was 43). The lake appears to have stabilized at a low eutrophic/high mesotrophic state. Its changes in trophic state are probably related to annual variations in nutrient loading which are driven by meteorological conditions.

Reformatory Lake. The Division of Water classified this lake as hypereutrophic in the 1984 305(b) report. Its aquatic life use was not supported because of severe hypolimnetic oxygen depletion and dissolved oxygen of less than 5 mg/l in the epilimnion. Subsequent investigations indicated that livestock operations in the watershed were the major source of nutrients which caused the degraded lake conditions.

Best management practices were implemented to reduce nutrient loading to the lake from these livestock operations with the help of the University of Kentucky Agricultural Extension Service. Monitoring of the lake in 1985 and 1986 showed that these practices brought about water quality improvements. Algal biomass had decreased, water clarity improved, and dissolved oxygen remained above 5 mg/l in the epilimnion, and there was less severe oxygen depletion in the hypolimnion. Total phosphorus, the nutrient of concern, had decreased.

Subsequent monitoring from 1987 through 1990 showed that there was a reversal in water quality. The lake was hypereutrophic in 1989 and again did not support aquatic life use. Site visits in the watershed in 1990 revealed that the best management practices had not been maintained and that nutrients from current livestock operations increased the phosphorus loading to the lake.

Livestock operations ceased in late 1990 due to economic factors. Monitoring in 1991 indicated an improvement in water quality. Dissolved oxygen in the epilimnion did not go below 5.0 mg/l. The lake was less eutrophic. Hypolimnetic oxygen depletion was still severe with dissolved oxygen less than 1 mg/l. The lake was moved from the not supporting category to partially supporting in this report because of the improved water quality. The Division is continuing to monitor the lake to document water quality conditions.

McNeely Lake. The Division is monitoring this lake to document changes in water quality as a result of the diversion of effluent from package treatment plants in the watershed to a pipeline that discharges at a location below the lake's dam. Three years of monitoring after this diversion (which began in December of 1988) have shown some improvement in water quality. The lake is no longer hypereutrophic as it was in 1987 and 1988. TSI values for 1989, 1990, and 1991 were 65, 64, and 66 respectively, which places it in the eutrophic category. Spring total phosphorus values in surface waters were 79 percent less after diversion. The average spring epilimnetic concentration dropped from 420 ug/l to 87 ug/l. This is still enough phosphorus to support eutrophic

conditions. The lake experienced dissolved oxygen concentrations of less than 5 mg/l in the epilimnion and had severe hypolimnetic oxygen depletion in 1991. These factors caused the lake to be categorized as not supporting aquatic life. The Division is continuing to monitor the lake to determine the nature of water quality improvements. Evidence from studies on sediment cores indicate that the lake was eutrophic before development occurred in the watershed. Some lower level of eutrophy may be all that can be expected of a lake of this nature.

Lake Jericho. Lake Jericho is a 137 acre lake in Henry County formed by a dam on the Little Kentucky River. It was first monitored by the Division in 1983. At that time the lake was eutrophic and had a mean TSI of 57. Its aquatic life use was fully supported. The lake was monitored again in 1989. Its TSI was 64, indicating it was eutrophic. It experienced dissolved oxygen problems in September when epilimnetic concentrations dropped below 3.0 mg/l and the hypolimnion had less than 1 mg/l. These low dissolved oxygen values caused the lake to be categorized as not supporting an aquatic life use. The Division has monitored the lake yearly since 1989 in order to document any worsening water quality conditions. In September of 1990 and 1991, similar low dissolved oxygen concentrations developed as in 1989. The lake was therefore categorized as continuing to not support aquatic life. The land use in the lake's watershed is largely agriculture (80%) and this activity is suspected to be the source of nutrients that cause the lake to be eutrophic and not support the aquatic life use.

Other Trends in Water Quality

Lake Acidification. The Division began monitoring three lakes in 1985 on an annual basis to document changes in water quality that could be attributed to acid precipitation. These lakes (Tyner, Bert Combs, and Cannon Creek) were the least buffered of any of the lakes sampled by the Division, which made them candidates for monitoring impacts from acid precipitation. Lakes with an acid neutralizing capacity (ANC) of 41 to 200 uequiv/l (2.5 to 10 mg/l total alkalinity) can be classified as moderately sensitive to acidification. The ANC averages for Tyner, Bert Combs and Cannon Creek lakes were 333, 188 and 160 uequiv/l respectively. These lakes have shown no detectible acidification trends. The monitoring program was discontinued in 1991. A baseline of water quality has been established in these lakes that can be compared to future studies.